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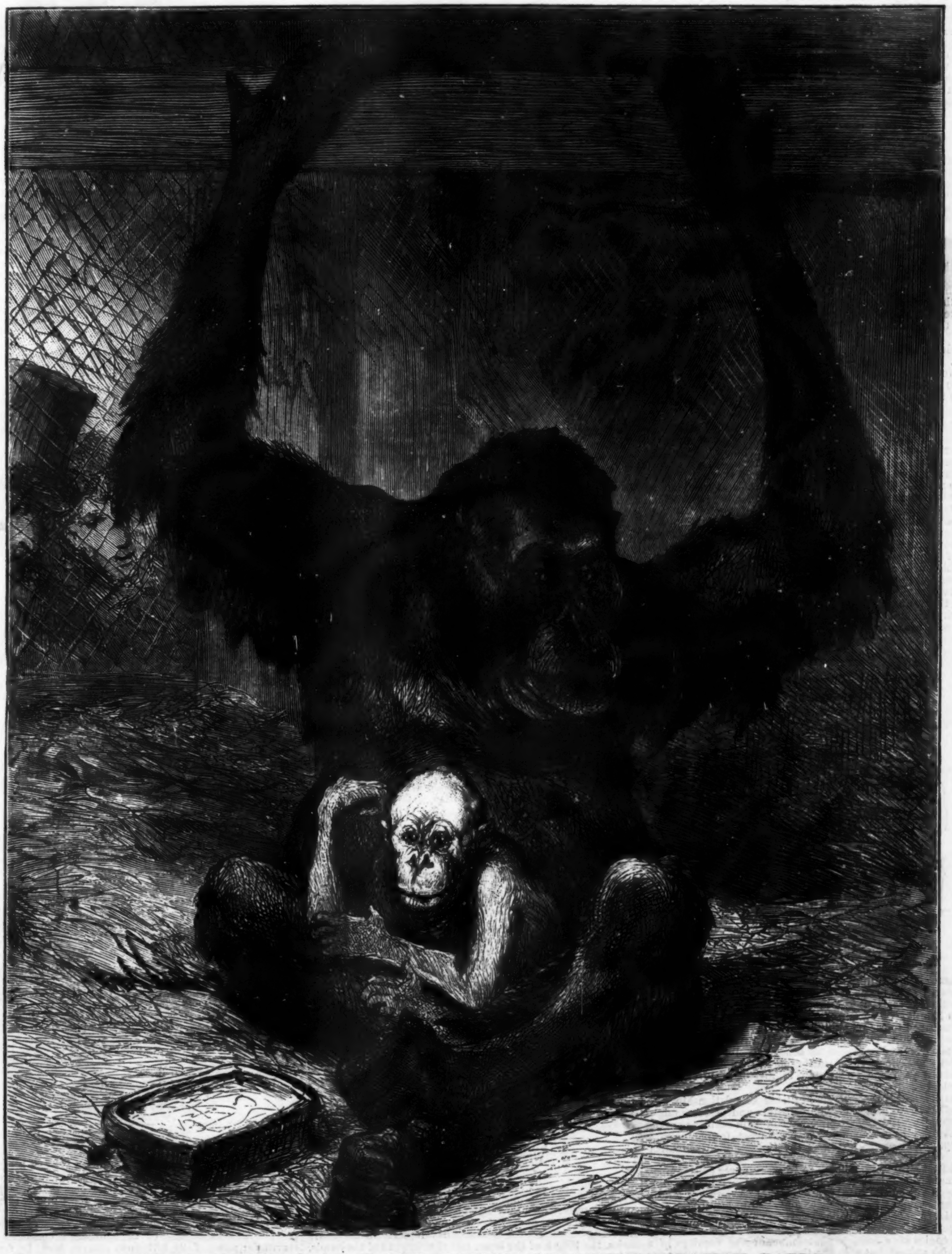


THE ORANG-OUTANGS OF THE GARDEN OF ACCLIMATIZATION, PARIS.

SOUTH AFRICAN BABOONS.

Mr. H. N. Moseley, in his "Notes by a Naturalist on the Challenger," says:

The officers of the ship liked Cape Town for its gayety and dancing. I enjoyed Simon's Bay most thoroughly, because it is a place where one can get at once among wild nature, and over the hills and moors, among the rocks, or along the coast, and come into immediate relation with examples of nearly all the characteristic South African animals in their wild condition.

I constantly crossed the high ridge of the Cape promontory, just above Simon's Bay, and made across to the shore on the other side. The whole promontory is one tract of open moorland, with only a few farms and houses of boers, with small holdings, scattered at long distances from one another.

On one of my first expeditions I came across a troop of baboons (*Cynocephalus porcarius*).

They are as big as a Newfoundland dog when full grown. They live especially about the sea cliffs and steep talus slopes leading down from these to the sea; but they are to be met with also on the open moorland above. They live in droves or clans of 30, 40, or even up to 70, and there were three such bodies of them in the country immediately about Simon's Bay, and in the tract stretching down to Cape Point. When on the feed, two or three keep watch, and one usually hears them before one sees them. The warning cry is like the German "hoch" much prolonged. As soon as they see one, three or four of them mount on the scattered rocks so as to have a clear view over the bushes and heaths, and watch every movement of the enemy, so that it is extremely difficult to get within shot of them. If one stands still, or does not go any nearer, merely passing by, they employ themselves, as they sit unconcernedly, in scratching in the usual monkey fashion; but still never losing sight of their object of suspicion.

Once I came across a troop on a sudden, on looking over a low cliff. They dashed off at a tremendous pace, galloping on all fours, till far out of shot, when they climbed up on to a rocky eminence, and calmly sat down to watch me.

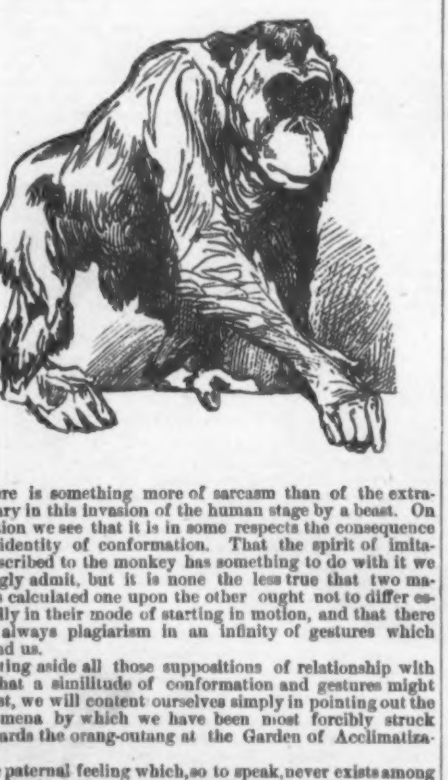
The baboons live on roots, which they dig up, and on fruits, and they turn over the stones to search for insects and such food underneath. It is striking thus to see monkeys roaming about an open moorland, where there are no trees.

I had never properly realized the fact before. The track of the baboons in the sand is unmistakable. The foot makes a mark, where the animal has been galloping, just like that of a child's foot; the fore limb makes a mark but half so deeply indented, the hand being used merely to touch on, as it were, to prepare for a fresh spring with the feet.

I found the skeleton of one of the baboons in a cave at Cape Point. The animal had evidently crawled into the cave to die.

THE ORANG.

The Garden of Acclimatization, says a writer in *L' Illustration*, has had more noisy attractions, but, it seems to us, never any that are more curious. Specimens of the great simian races—orang-outangs or chimpanzees—have been seen at Paris before, and, like the two animals there at present, have astonished the crowd not only by their stature, but by their intelligence, and especially by the facility with which they adopted some of the refinements of our civilization. Some twenty years ago, we went to see at London a female chimpanzee whose manners would not have shamed the best society; she seated herself at the table, made use of a spoon and fork properly, poured out something to drink into a tumbler, drank it, wiped her lips with a napkin, sugared her tea, and waited patiently until the cup became cool; made her bed *secundum artem*, got between the blankets, and gathered them up around her head with the most exemplary gravity, and all this without any kind of intervention on the part of her keeper.



There is something more of sarcasm than of the extraordinary in this invasion of the human stage by a beast. On reflection we see that it is in some respects the consequence of an identity of conformation. That the spirit of imitation ascribed to the monkey has something to do with it we willingly admit, but it is none the less true that two machines calculated one upon the other ought not to differ essentially in their mode of starting in motion, and that there is not always plagiarism in an infinity of gestures which astound us.

Putting aside all those suppositions of relationship with man that a similitude of conformation and gestures might suggest, we will content ourselves simply in pointing out the phenomena by which we have been most forcibly struck as regards the orang-outang at the Garden of Acclimatization.

The paternal feeling which, so to speak, never exists among the mammifera, is seen to be highly developed in this monkey. He has constituted himself the father-nurse of a little orphan orang, and accomplishes his self-imposed task with a patience, perseverance, and an amount of affection that are both exemplary and touching. And these are not the vain copies of a human pantomime, or the caprices of a freakish animal, but they are the sincere demonstrations of deep feeling. We willingly admit that, among reasoning creatures, all fathers are susceptible of experiencing it, but we doubt, however, whether all are capable of putting at the service of this duty as much inquiet solicitude and as much constancy of attention. The latter are the more remarkable in that the turbulence of the droll young one puts them to a terrible proof. And they are especially so because the stronger sex of the simian races, while making occa-

sional shows of fierce fits of jealousy, are not the less, for all that, very fickle in their loves, and their monogamy is not much more exemplary than that of bipeds for good. We say for good, because the quadrumana under consideration are in reality only imperfect bipeds. They have been for a long time closely observed by a member of our staff,

who is not only a clever artist, but at the same time a reflecting thinker, and, during the many long hours that he has given to their study, he has never seen the adult orang assume a vertical position without the aid of some object to lift himself by. This observation accords perfectly with the narratives of those travelers who have met with the animal in his

native forests: when they have been seen standing upright they were leaning on a stick. The physical characteristics of the orang-outang are the excessive development of the maxillaries, the length of the arms, and the strength of the hands. The nose, as in other monkeys, is rudimentary. The fleshy, very contractile lips, which cover the formidable jaw, take in this rough sketch of humanity, an active part in the process of eating. As to the hands and arms, they are visibly the principal levers of this creature. The posterior members, notwithstanding the prehensible faculties that they share with the former, are only auxiliaries to them. In repose, the monkey constantly holds his arms aloft, and his hands crossed over his head, as shown in the accompany-

ing sketch. He incessantly returns to this position, and, if one of his hands is occupied, he covers his cranium with the one which remains free. Is the nudity of the sinciput, then, considered unbecoming among the orangs, as it is among the children of Israel? Or does this continued action denote that such is the best position for members whose length is embarrassing? The latter is the more probable supposition of the two. However it may be, it is certain that such is the posture in a state of nature. Another reason has been given by M. Lançon: the hairs of the forearms of orang-outangs, instead of lying in the direction of the hand, point in the opposite direction, and in such a way that when the animal covers his head with his hands they shed the rain

when it happens to fall on them. This posture, then, might be the result of a certain amount of sensitiveness of the cranial region and of the necessity of protecting it. This region, as may be judged from the profile of the young orang, is not less developed than it is in certain negroes; the forehead does not retreat any more, and is not higher than theirs. Cover the lower portion of the orang's face—the part of the physiognomy which is truly bestial, and what remains might, without any unlikelihood, be referred to some honorable individual of an African or Oceanic people. The moral study of these poor beings leaves one sad, and with a feeling of pity, which even the wonderful agility of the nursling does not succeed in removing. The latter supports his captivity with the happy indifference of his age; but the sufferings of the adult orang are painful. Your curiosity troubles him; the enormous crowd that he attracts to the Garden of Acclimatization fatigues him, and, as might be supposed, becomes odious to him. One evening, M. Lançon, who had gotten rid of the public so as to enjoy his models more at his leisure, desiring to see the animal, who had squatted in

his melancholy attitude, stand up, began to call him. The orang straightened himself up impatiently, came to him, and with an imperious gesture, and one that was purely human, made a sign to him to "clear out," saying to him, as much by his look as with the motion of his hand: "Well, what are *you* doing here, now that my hour of torture is past?" This fallen king of the solitudes is conscious of his servitude; none of its bitterness escapes him; he feels, he comprehends at every moment that he no longer belongs to himself. And it is much worse than the work of the slave

bent under the lash; for the latter, during his labor, keeps his thoughts free, but the poor orang has lost all, even the faculty of deceiving his great ennui by dreaming. It is in vain that, gathered up in a heap and hugging the unfortunate little companion of his miseries, he tries to live over again his past days, and to see again the tropical forests in which he was born, for the curiosity of the crowd is too in-

satiable to allow him. It insists on having the satisfaction of seeing him stand, walk, climb, eat, and make grimaces.

The orangs' meals are naturally one of the attractions that the public is most fond of. The animals await the hour of these without impatience, and with that gravity which, in the adult, characterizes all their acts, and presents such a striking contrast with the turbulence of smaller monkeys.

Rice, which forms the base of their food, is served to them in a basin. The large orang makes his pupil sit down by his side, and eats with good appetite, in a peculiar manner, but without any show of greediness. He takes up a certain quantity of his food by the aid of his lips, chews it for a long time, and somewhat methodically spits it out into his long hand, and then eats it in small portions. The nursling is in-

finitely less correct in his deportment at the table; it is not rare to see him seize a handful of rice, put it quickly in his mouth, seize the rope, dart aloft among the upper beams of the cage, and, while eating, hang head downward or turn a somersault.

But the process of retiring to bed is undoubtedly the most curious part of the exhibition, not only because it is that in which the paternal cares of the father-nurse are most forcibly shown, but also because on being given the materials for his bedding he disposes of it just as you or we or any one else would do. It is interesting to observe the minute cares with which, after stirring up the straw that represents the mattress, the orang spreads over his couch one of the four blankets that are allowed him, and with what art he fixes and smooths it. The bed made, it becomes a question of

getting his foster-child to come and take his place in it; and this, to tell the truth, is the hardest part of his task. It is just exactly the moment that the youngster chooses to give himself up to his most eccentric gambols and to his most extravagant gymnastics, passing from the bars to the cord, and from the cord to the bars, with surprising agility. The good-natured monkey at first shows an exemplary patience his reprimand is all contained in his facial expression; his expressive eyes wander by turns from the recalcitrant pupil to the made-up bed, and very clearly say to him that bedtime has arrived. The youngster very rarely complies with his invitation; and then the foster-father in his turn seizes the rope with one hand, and at a single bound (which gives some idea of his prodigious strength) arrives in the upper regions where his refractory charge is gamboling, catches him with one paw, and carries him off as if he were a feather, puts him in bed, and at once covers him with the second blanket. In most cases, the capricious young one selects the moment in which the old orang is looking for the third blanket, to escape and betake himself to a new race over the beams. This time he is at once seized by the body and reinstated in his bed. But his tutor, no matter how bad a humor he may be in, never bestows on him any of those manual corrections which the females of all the simian races are accustomed to administer to their progeny. Finally, the fourth blanket is spread with the same little attentions as the other three were, and then the old monkey gently raises them, glides in alongside of his adopted child whose eyes are already closed, takes him in his arms, and falls asleep in his turn. From this moment he is rid of his miseries.

ORANG-OUTANGS IN BORNEO.

Among the papers read at the recent Saratoga meeting of the American Association was one by William T. Hornaday, of Rochester, on Bornean orang-outangs and their habits. A big specimen, looking very grim, was shown on the platform in a natural attitude, and the paper was also illustrated by a large picture of Mr. Hornaday's pet orang.

In his notes Mr. Hornaday said:

Borneo is the land of apes and monkeys. It contains thirteen species of quadrumana. Leaving the *genus homo* out of the question, the orang-outang occupies the third place from the highest in the kingdom. The gorilla is given the highest place, next in order the chimpanzee, and third the orang-outang. The orang agrees with the gorilla and chimpanzee in positive size and quality of the brain, but its fore limbs as compared with the hind limbs are longer than theirs. Among the higher apes the orang comes nearest to man in the number of ribs (twelve pairs) and form of the cerebral hemispheres, but differs from him in other respects, especially in the limbs, more than do the gorilla and chimpanzee. The male orang is marked by remarkable cheek callosities. These seem purely ornamental and are not controlled by voluntary muscles. They vary in width from 10½ to 13½ inches. The most striking feature of the orang is in its massive and muscular arm and hand, on which the animal depends mainly for locomotion. When an orang is asleep the most natural position he can assume is grasping firmly a branch with each hand. Sometimes the hair is abundant, coarse, and ten to fifteen inches in length, and in other specimens it is scanty, short, and much finer. The loose skin on the throat and breast often hangs in a great baggy fold. Externally the orang seems to have no neck at all, the head being set squarely down upon the shoulders. The chest is massive, but the pelvis is small, and the lower limbs are small, short, and comparatively weak. The orang never sits down. The legs seem to possess almost as much freedom of movement as the arms.

Each individual of the Bornean orangs differs from his fellows, and has as many facial peculiarities belonging to himself alone as can be found in the individuals of any unmixed race of human beings. According to my experience, Mr. Hornaday said, orangs differ from each other fully as much as either Chinese or Japanese, if not more. The faces of the more intelligent orangs are capable of a great variety of expression, and in some the exhibition of the various passions which are popularly supposed to belong to human beings alone, is truly remarkable. I had in my possession in Borneo four young living orangs. Three were dull and intractable, but the fourth was a perpetual wonder both to Europeans and the natives themselves. For weeks it lived in the same room with me, so that I watched it almost constantly. The expression of its face was highly intelligent, while the intellectual development of its forehead and entire cranium would have been quite alarming to any enemy of the theory of evolution. This specimen was a fine healthy male infant about seven or eight months old, 22¼ inches in height, 37 inches in extent of arms, and 15¼ pounds in weight. He exhibited fully as much intelligence as any child under two years of age, with all the emotions of affection, dislike, anger, fear, cunning playfulness, and even ennui. When teased beyond endurance he would first whine fitfully, but if the teasing were continued, he would throw himself upon the floor, kicking and screaming, and catching his breath as loudly and naturally as a big spoiled child. He was afraid of strangers as a rule, but decidedly attached to my Chinese servant and myself. When alarmed by a large dog or other animal, he would shuffle up to me and climb with all haste into my arms. When a cat came near him he would grab it by the tail with the very same action and bright, mischievous expression of face that we have all seen in human children.

THE ORANG'S FIGHTING PROPENSITIES.

Male orangs are much given to fighting, continued Mr. Hornaday, as numerous scars on some of our specimens plainly show. Being purely fruit-eating animals, their huge canine teeth seem to have been given them solely as weapons of defense and offense. Orang No. 11 carried the scars of many a hard-fought battle in the tree tops. Large pieces had been bitten out of both lips, and his middle fingers had been bitten off. He had also lost two of his toes in this way. Whenever my baby orang become angry with me he would seize me by the wrist and draw my hand up to his mouth. * * * In Borneo the orang-outang inhabits that wide belt of low forest-covered swamp which lies between the sea coast and the mountain ranges of the interior, extending entirely around the western half of the island. Last year while on a collecting expedition for Professor H. A. Ward, I had ample opportunities to study the habits of the orang-outang in its native forests. I visited Borneo in August, 1878, for the sole purpose of obtaining specimens of the Bornean simia, and to study the different species. I visited the territory of Sarawak, and for two and a half months devoted my entire time to hunting the orang along the river Sadong and its tributary the Simujan. This whole region is one vast swamp, covered everywhere with a dense growth of lofty virgin forest. During the fruit season, from the middle of January to May 1, the food of the orang is the durion, mongasteen, and rambuton. During the hot months of May, June, and July, they retire far into the depths of the forest and are exceedingly difficult to find. But during the season of the heaviest rains, from August to November, when the forests are flooded, the orang are found in the vicinity of the rivers. I soon found that the only way to reach them would be to paddle up and down the rivers and watch for them in the tree tops. Near the source of the Simujan river and far beyond the last Dyak village we found great numbers of old orang nests and some which were quite new. The nest consists of a quantity of leafy branches broken off and piled loosely into the fork of a tree. The orang usually selects a sapling and builds his nest in its top, even though his weight causes it to sway alarmingly. He often builds his nest within twenty-five feet of the ground, and seldom higher than forty feet. Sometimes it is fully three feet in diameter, but usually not more than two, and quite flat on the top. There is no weaving together of branches. In short the orang builds a nest precisely as a man would build one for himself, were he obliged to pass a night in a tree-top and had nothing to cut branches with. I have seen one or two such nests of men in the forest, where the builder had only his bare hands to work with, and they were just as rudely constructed, of just such materials, and in about the same position as the average orang nest. Upon this leafy platform the orang lies prone upon his back, with his long arms and short thick legs thrust outward and upward, firmly grasping while he sleeps the nearest large branches within his reach. On several occasions I surprised these animals upon their nests, and once I had an opportunity to watch an orang while it constructed its resting place. He never uses a nest after the leaves become withered and dry, no doubt because the bare branches are not comfortable to lie upon. I never saw or heard of any house building by orang-outangs.

We found the animals most numerous along the Simujan river near its source. Our manner of hunting was to make trips up and down the river in our boat, paddling slowly and silently along, keeping a careful lookout. Sometimes in rounding a bend in the river we would come full upon a huge black-faced, red-haired animal, reposing quietly or feeding. I aimed to shoot them through the chest, and thus either kill them at once or disable them so that they would be unable to get away. On several occasions I succeeded in killing a large specimen with a single bullet. It would at all times have been an easy matter to have shot them through the head, but this would have ruined the skulls. As soon as an orang was fired at, if not killed at once, he would begin climbing away with all haste.

I think we may fairly consider the orangs the most helpless of all quadrumana. Owing to the great weight of their bodies and the peculiar structure of their hands they cannot run nimbly along even the largest branches, and never dare to spring from one tree to the next. The weight of the adult male ranges from 120 to 160 pounds. Owing to the disproportionate shortness of his legs, his progress depends mainly upon his long, sinewy arms, and very often he goes swinging through a treetop by their aid alone. Upon the ground orangs are a picture of the most abject helplessness, and in their native forest they are very seldom known to descend to the earth. They are utterly incapable of standing fully erect without touching the ground with their hands, and for them to be represented in drawings and museums as standing erect is contrary to nature.

THE ORANG AND EVOLUTION.

In conclusion, Mr. Hornaday remarked: We will not say anything about the part of orangs in the long chain of evolution, for we feel that no one present will wish to admit his or her relationship. But while abstract argument leads hither and thither, according as this or that writer is most ably gifted for argument, there is still one influence to which every true naturalist is amenable, and which no one will ignore who has studied from nature any group of natural forms. Let such a one (if indeed such a one exists today), who is prejudiced against Darwinian views, go to the forests of Borneo. Let him there watch from day to day this strangely human form in all its various phases of existence. Let him see it climb, walk, build its nest, eat and drink, and fight like human "roughs." Let him see the female suckle her young and carry it astride her hip precisely as do the cooly women of Hindostan. Let him witness their human-like emotions of affection, satisfaction, pain, and childish rage—let him see all this, and then he may feel how much more patent has been this lesson than all he has read in pages of abstract ratiocination.

The N. Y. *Tribune* says that one of Mr. Hornaday's hearers humorously suggested in conversation afterward that he could not see how any one with Darwinian opinions could go through such an experience as Mr. Hornaday urges, and then put a bullet into this human-like form without feeling that he had murdered a distant relative, possibly a mother-in-law of one of his ancestors in a prehistoric age.

THE HOMING INSTINCT IN PIGEONS.

MR. ERNEST INGERSOLL contributes to the November *Scribner* a curiously interesting paper on "How Animals get Home," from which we clip these paragraphs. Mr. Ingersoll rejects the theory of any special homing instinct, attributing the remarkable examples of returning animals to an attentive use of the senses.

One of the most striking powers possessed by animals is that of finding their way home from a great distance, and over a road with which they are supposed to be unacquainted. It has long been a question whether we are to attribute these remarkable performances to a purely intuitive perception by the animal of the direction and the practicable route to his home, or whether they are the results of a conscious study of the situation, and a definite carrying out of well-judged plans.

Probably the most prominent example of this wonderful power is the case of homing pigeons. These pigeons are very strong of wing, and their intelligence is cultivated to a high degree; for their peculiar "gift" has been made use of since "time whereof the memory of man runneth not to the contrary." The principle of heredity, therefore, now acts with much force; nevertheless, each young bird must be subjected to severe training in order to fit it for those arduous competitions which annually take place amongst first-rate birds.

As soon as the fledgling is fairly strong on its wings, it is taken a few miles from the cote and released. It rises into the air, looks about it, and starts straightway for home. There is no mystery about this at all. When it has attained the height of a few yards the bird can see its cote, and full of that strong love of home which is so characteristic of its wild ancestors, the blue-rocks, it hastens back to the society of its mates. The next day the trial distance is doubled, and the third day is still further increased, until in a few weeks it will return from a distance of seventy miles, which is all that a bird-of-the-year is "fit" to do; and when two years old, will return from 200 miles, longer distances being left to more mature birds. But all this training must be in a continuous direction; if the first lesson was toward the east, subsequent lessons must also be, nor can the added distance each time exceed a certain limit, for then, after trying this way and that, and failing to recognize any landmark, the bird will simply come back to where it was thrown up. Moreover, it must always be clear weather. Homing pigeons will make no attempt to start in a fog, or, if they do get away, a hundred chances to one they will be lost. Nor do they travel at night, but settle down at dusk and renew their journey in the morning. When snow disguises the landscape, also, many pigeons go astray. None of these circumstances seriously hampers the semi-annual migrations of swallows or geese. They journey at night, as well as by day, straight over vast bodies of water and flat deserts, true to the north or south. Homing pigeons fly northward or southward, east or west, equally well, and it is evident that their course is guided only by observation. Watch one tossed. On strong pinions it mounts straight up into the air a hundred feet. Then it begins to sweep around in great circles, rising higher and higher, until—if the locality is seventy-five or one hundred miles beyond where it has ever been before—it will go almost out of sight. Then suddenly you will see it strike off upon a straight course, and that course is homeward. But take the same bird there a second time, and none of these aerial evolutions will occur—its time is too pressing, its homesickness too intense for that; instantly it will turn its face toward its owner's dovecote.

PHYLLOXERA.

ONE of the many interesting exhibits at the National Exhibition and Market now open at the Agricultural Hall, Islington, is a collection of specimens of *Phylloxera vastatrix*, shown under the microscope by Mr. Richard Blandy. The insects are here to be seen, either alive or dead, in the different stages of their growth. Taking the exhibits in order, there will be noticed, with the unassisted eye, what appears to be a fine yellow dust, rather like the pollen of a flower, on the glass slide in the first instrument. This, examined through the microscope, is seen to be the young creature. The next stand shows an adult insect, with the fine rostrum or tube through which it sucks the sap from the vine root. In the third instrument are specimens of the nymph, with wing-cases which protect the exceedingly delicate wings during the subterranean life of the creature. Mr. Leacock, the owner of the vineyard in Madeira whence the specimens here shown were brought, has, with a magnifying glass, while lying on the ground in early summer, watched the fully developed insects coming to the surface through cracks in the earth. When above ground they spread their wings, and seem to be blown away rather than to fly. Some of the winged insects are shown. In the two remaining microscopes are live specimens brought over sticking to pieces of vine-roots, which have been kept in a bottle in this country for about a fortnight. As may be supposed, the roots are now dry and afford but little nourishment, yet many of the insects are still active and appear to be doing well. Some shoots from plants of which the roots have been attacked are also exhibited, in order to show what may be done by the viticulturist to diminish the injury caused by this pest, and even to restore the health of the vine. In a little pamphlet distributed to visitors it is stated that in Madeira Mr. Leacock has succeeded in checking the general destruction of the vines on his estate. His mode of dealing with phylloxera is to lay bare the underground stem and principal roots of the vines as far as this may be done safely. The loose bark, on which the insects are generally thickly clustered, is burnt, or put into boiling water. The lower part of the stem and the roots are then coated with a preparation of turpentine and resin, about 3½ oz. of finely powdered resin being added to each quart of turpentine. When gently heated the mixture becomes thick enough to form a cohesive coating to the roots. This stuff destroys the insects touched by it, and those lower down, prevented from working upward, die off as their food fails by the destruction of the roots below them. The turpentine mixture is applied in the autumn and winter, and the plants are at the same time well manured. There may not be any very marked improvement in the first year after this treatment, but next year the new roots will have been thrown out, and the plants will not require to be treated in this way again for four or five years.

Some wine made from the fruit of plants that have thus been saved and restored to health has been sent to this exhibition. Other vine-growers in the island, it is added, are adopting Mr. Leacock's plan of dealing with the phylloxera, and so far as Madeira is concerned the plague is believed to be stayed.—*London Times.*

HEDGEHOG AND VIPER.

THE common hedgehog is generally described as a mortal enemy to snakes of all kinds, and it has been supposed that he enjoys an immunity from the effects of the bites of the venomous species. M. Samie, with a circumstantiality which reminds one of the reports of prize fights in *Bell's Life* during the palmy days of the ring, relates all the particulars of a combat which he excited between a hedgehog and a viper (*Vipera aspis*). The hedgehog attacked the snake as soon as he was aware of its presence, seizing it in the first place at the hinder part of the body, and continuing his assaults until his formidable enemy was reduced to a helpless state, when he commenced eating it at the tail end; afterwards, proceeding to the head, he carefully detached and devoured the *lower jaw*. The viper was still alive. The most interesting point brought out by this experiment of M. Samie's is the mode in which the hedgehog defended himself against the dangerous weapons possessed by his adversary. When bitten, the viper at first turned to strike its assailant, when the hedgehog immediately drew forward over his head that mass of spines which forms the front part of his defenses; and when the snake struck open-mouthed at its persecutor, its attack was foiled by this formidable *cheval-de-frise*. Several times the same maneuver was repeated, until the snake's mouth was so severely lacerated that it no longer attempted to use its fangs, but sought safety in vain in flight. The hedgehog frequently rolled himself up for a time after having made an attack upon his victim. M. Samie's results are interesting, but it is clear that he has not the fear of antivivisectionists before his eyes.—*Actes Soc. Linn. de Bordeaux.*

NEW EXPLORATIONS OF THE RUINS AT PALENQUE, MEXICO.

M. F. MALER, who has been making explorations in Mexico, writes as follows to *La Nature* in regard to some interesting discoveries made by him among the ruins of Palenque:

When coming from San Cristobal de Las Casas, the modest capital of the State of Chiapa, we arrived in the month of July, 1877, at the celebrated ruins near the little village called El Palenque, with the intention of taking photographic views there. We scarcely hoped to find anything new in a spot so well explored by Stevens, Waldeck, and Dupaix. Nevertheless, without allowing ourselves to get discouraged, we left our baggage in one of the spacious courts of the Palace of the Kings, where we had temporarily located ourselves, and bravely undertook a thorough exploration. Accompanied by a few Maya and Tzendal Indians, we traveled over the country for twenty days in every direction imaginable; and visited, on the sides of a chain of low mountains, hidden beneath an evergreen mantle of dense vegetation, the curious evidences of an unknown civilization. The irregularity of the country, and the obstacles that met us in the form of the exuberant vegetation which covers it, were such that we were rarely able to walk upright, in spite of the constant use that the Indians made of their machetes in order to open up a road for us through the underbrush and hanging vines. Making use of hands as much as of feet, we climbed and we slid, and even crawled beneath the underbrush. Advancing thus by degrees, and carefully examining everything that we found remarkable, we crossed a number of small brooks, where our Indians stopped to gather "shoti" (*Melania levissima*)—a fluviatile mollusk, which is highly appreciated as a dainty by them. We scaled walls of calcareous rock, almost inaccessible, where we obtained hearts of palm trees, called "chapay" by the Indians, and which, when slightly roasted, are the most delicate morsel that a tropical forest furnishes. Every day we killed black-plumaged "Crox" (*Penelope purpurascens;* "Coshotitli" of the Aztecs).

Occasionally we halted in fright in the presence of enormous coiled serpents—the terrible "nahuyacas"—causing us to retrace our steps noiselessly so as not to startle them. Taking the Palace of the Kings as our point of departure, we multiplied our excursions in all directions, arresting our steps only at the extreme limit of the vestiges of the ruins. In our way we came upon innumerable heaps of stones—the last expression of the most solid of human monuments. We found hundreds of houses, partially standing, partially in ruins; small bridges; and some aqueducts in which, even at the present day, the water flows so cool and pure that when we looked at it we could not refrain from drinking it. Defying jaguars or pumas, we many a time descended into extensive galleries which were formerly the lower floors of sumptuous edifices, but to-day are merely dark tunnels. Finally, we ascended enormous pyramids, which are still crowned with their aerial buildings. The exact number of temples and of palaces still standing on their pyramidal bases is (counting the Palace of the Kings with its tower as sole edifice) twelve. It is impossible for us to offer the reader the complete results of our exploration, and to exhibit the whole series of photographs which, notwithstanding the feeble light that prevails in these forests, we succeeded perfectly in obtaining. We will simply remark that the result of our researches relative to the great extent of

FIG. 1.—SCULPTURE WITH A CRUCIFORM FIGURE, DISCOVERED BY M. MALER, NEAR PALENQUE.

FIG. 2.—ANCIENT TEMPLE RECENTLY DISCOVERED NEAR PALENQUE, MEXICO. (From a Photograph.)

the ruined city (especially in the direction east to west) is in perfect accordance with what is told us by the oldest explorers, Calderon, Bernasconi, and Dupaix. We disagree only with the narratives of modern travelers who, having visited the edifices situated very near the Palace of the Kings, without penetrating further into the inextricable forest, have doubted the abundance of the ruins.

A single one of our discoveries—but, at the same time, the most interesting one—will form the special object of this article. We desire to speak of a temple which has hitherto been entirely unknown, and which hides within its sanctuary a mysterious piece of sculpture with a cruciform figure, very worthy of being reflected upon by American archæologists (Figs. 1 and 2). In order to give an idea of the incredible density of the virgin forests in these desert places, we will state that the new temple is found, not at a great distance from the center of the ruins, but, on the contrary, quite near the Temple of the Cross (long known) and the Temple of the Trophy; the latter being in the form of two spears with a shield in the center, and called "Sun" also, because of the round form of the shield, which other travelers have taken for an image of the sun. These three temples are situated at a slight distance from the Royal Palace, toward the south-east—that is, in the direction of Cerro Alto del Palenque — with their façades turned toward a little triangular *plaza*, whose three angles they occupy. They are built upon a plan which is almost identical, and which may be called the typical one of the Palenque temples. Each one of them arises from a pyramid, which, in the two temples that have been long known, is free on every side, but in the last one discovered is built against the slope of Cerro Alto. The distance between the temples (which is something difficult to estimate) does not appear to exceed four hundred and fifty feet, and that between the foundations of the pyramids not even one hundred and fifty feet. The astonishing exuberance of the vegetation, connected with the fact that the pyramidal basement of the *adoratoire* forms a part of the very mountain, explains how this monument has been able to escape the attention of our illustrious predecessors. From the top of the pyramid, which is perhaps 125 feet high, arises the temple, which, from its base to the crest of the stone roof, does not exceed 25 feet in height. It is built entirely of undressed calcareous stones covered with stucco. The façade, or external portion of the vestibule, which, as in the two neighboring temples, was originally formed of four pillars sustaining the stone roof, has unhappily already ceded to the destructive action of the vegetation; and this is the more to be regretted, because these pillars were generally ornamented with superb figures in stucco and richly painted. The lower end of the sanctuary, in the central room, is ornamented with the most curious sculptures to be found in Palenque. They are executed on three slabs of calcareous stone, measuring six feet in height by a total length of 9½ feet. The two pillars which sustain the vault of the sanctuary were, as in the other temples, originally decorated with figures sculptured on large slabs of limestone, but which have now disappeared. Some bits of the e figures, representing richly clothed personages, were still lying on the threshold, but it was impossible for us to put them together to obtain the general appearance of the two slabs. As an offset to this, the sculpture at the extreme end of the sanctuary is still perfectly preserved and quite visible, in spite of its slight relief. In a single place are seen the traces of a sacrilegious hand, which, by the aid of a lever, has vainly endeavored to pry these precious slabs from the wall. Upon a kind of stand is raised a cross (Fig. 1), of a much more striking design than that of the one in the neighboring temple, and which is so universally known. This cross is surmounted by a strange head, wearing around its neck a collar and medallion, the usual ornament among all great personages of Palenque. Ought we to regard this curious head, seemingly decorated with two horns, as a vague souvenir of the North American bison, or ought we to see therein the last traces of an almost effaced Christianity, which, in remote times, may have found its way from the distant races of Atlantis? These are questions difficult to answer. Above the cross is perched a bird with a hieroglyphical head. On the right stands a man on a graceful foliage. This person is not clothed like the great lords of Palenque, and undoubtedly represents one of the common people, as does the woman opposite to him. The latter holds an offering in her hand. In the left hand of the man is seen a small object difficult of explanation, but having some resemblance to the symbol of life, otherwise called the "handled cross," and which so many of the Egyptian statues hold in the same way. Both the man and woman have their mouths open, as a sign that they are speaking to the gods. Four rows of "Katun" (or Maya signs of writing) to the right and left of the figures, undoubtedly contain the information as to the worship to which the temple was dedicated, and as to the time of its foundation. We must decline an attempt to decipher them, and we must frankly confess that so long as we shall have at our disposal nothing but the key furnished by the fanatical Bishop of Yucatan, Fray Diego de Sanda (in his "*Relacion de las Cosas de Yucatan*"), we shall never undertake a like task. This unfortunate individual, who has taken such a sad share in the destruction of Maya manuscripts, has left nothing to posterity in exchange for these irreparable losses but a scrawl which is as absurd as it is useless.

LEXINGTON OIL BELT—SANTA CLARA COUNTY, CALIFORNIA.

A LATE number of the San José *Mercury* contains an account of the above oil belt, its developments, and history. It says: So many rumors of big things in oil have come to us from the Lexington oil region during the last fifteen years, which afterwards proved to be largely of a fabulous character, that the public had crystallized into a condition of chronic doubt concerning the possibility of a pay strike in that section. Although it has been well known that oil existed here, yet but few people, especially after the first experiments at well-boring had been made, had any faith in the ultimate value of the district for oil mining.

Many of our older residents will remember the oil spring in what is known as Moody's gulch. This gulch is about two miles above Lexington, crossing the Santa Cruz road. The spring was located a few hundred yards above the road. Other and numerous indications of oil existed along a belt of country stretching across the hills and gulches in a southerly direction for a distance of five or six miles.

It was in 1865, we believe, when the first well known as the McLeran well, was sunk in Moody's gulch, near where once stood Moody's sawmills. This well was bored to the depth of some 400 or 500 feet, and a flow of about a barrel of oil a day procured. The well-boring tools were of a primitive order, and many difficulties were encountered from inexperience and imperfect machinery. Some of the principal tools were finally stuck in the well, where they remain to this day. A year later, over the summit, and about four miles from the McLeran well, the Fargo well was bored to the depth of about 400 feet, and about the same quantity of oil obtained as at the former. This was also abandoned as of no particular value. The same year Messrs. Pulsifer and Gould bored a well on the Griswold place, some two miles back of Lexington, to the depth, we believe, of about 500 feet. They found some oil and a considerable quantity of salt water. None of these wells were sunk deep enough. One or two other efforts were made at that time and then the work was abandoned for ten years, and until the organization of the Santa Clara Petroleum Co., when Col. Boyer took the matter in hand. With improved machinery and experienced assistants, the well, known as the Boyer well, was bored in the Moody gulch, to the depth of 940 feet.

At the depth of 700 feet a flow of from two to three barrels of oil was obtained, but no genuine oil rock was found, indicating that the well was at one side and near the true rock. For the past year this well has yielded and continues to yield about the quantity of oil named.

About a year ago the company became involved in new complications. Boyer was sold out by the sheriff and disappeared from the scene, and new men came to the front. Among these were Charlie Felton, a man of indomitable pluck and a solid substratum of coin; and also R. C. McPherson, an experienced oil man from the Pennsylvania oil district, who was subsequently foremost in developing the Los Angeles oil district. It is to the sound judgment and true grit of Mr. McPherson, more perhaps than to any other person, that the company has kept steadily to its work for the last year and a half. He brought with him from Los Angeles some of his most experienced helpers, and imported from the East the best well-boring machinery to be had, and has pressed the work steadily forward to the present time.

Commencing a new well about 150 feet above the Boyer well, at a depth of a little over 700 feet the drill, a few days ago, penetrated the true oil sand rock. The result was most astonishing. So powerful was the escaping gas that the oil was thrown to the height of 100 feet, drenching the derrick and buildings, and flowing down the cañon. It is estimated that at least 100 barrels of oil was wasted before the well could be secured. Since then *she* (oil men always speak of a well as of the feminine gender, and often apply pet names to her) has acted like a "Little Daisy." The flow has been fully 60 barrels per day of the finest green oil, of from 46 to 47 standard gravity, while the standard of the best Pennsylvania wells is only 45 grade. As the best evidence of the genuineness of this strike we may state that during the brief period it has been in operation the company has shipped some 300 barrels of oil by the narrow gauge railroad. The oil at present is piped down the gulch to the turnpike, and thence hauled to Alma station about a mile distant. It is the intention soon to pipe it through to the railroad, and eventually, probably, to San José.

About 200 feet up the gulch from the main well work is progressing for another well, and will be pushed forward speedily to completion. The company is also preparing to bore a well over the range on the Taylor place. Near the latter place work is progressing rapidly on what is known as the Whiteside well, under the same company. The altitude here is about 300 feet above that of Moody gulch. The well is now down nearly 800 feet, and is in most encouraging rock. It is near here that the O. L. Crandell and Hy Morrill claim is located, one of the largest and most promising prospects in the oil belt. (And here we take pleasure in adding parenthetically that Mr. Crandell has stood in from the first in the oil business, and never lost faith in the ultimate results. The prospect is now luminous that a rich reward will gladden the remainder of his days, which we hope may be many.)

A number of new rigs will be prepared as soon as practicable, and in a short time from six to eight wells will be going down at once. In fact, the certain success already attained will so stimulate enterprise in this direction, that we may reasonably expect the time is near at hand when our oil regions will swarm with busy laborers, and millions be added to the wealth of our county and State.

THE SUTRO TUNNEL.

An Address before the Bullion Club, New York, by ADOLPH SUTRO.

DISCOVERY OF THE FIRST SILVER MINE.

GENTLEMEN: It is just twenty years since the Comstock lode was discovered in what was then a portion of the Territory of Utah. It was, as far as I am informed, the first discovery of a real silver mine within the borders of the United States, and, strange to say, it has proved to be not only one of the most valuable that has been found in the United States, but, in all probability, it will prove the most productive deposit of the precious metals of any known in the world. The yield thus far amounts to about four hundred millions of dollars in bullion; and at least an equal amount in low grade ores has actually been developed; but which ores, as I shall hereafter explain, have thus far not been extracted.

Strange as it appears, that the first silver lode discovered in the great West should have proved to be the most productive, it is equally strange that the first ore extracted from it should have been the richest. The first forty tons of ore taken from the Ophir mine on the Comstock lode were packed on mules and sent across the Sierra Nevadas to San Francisco, and yielded $160,000, or an average of $4,000 per ton; and no body of ore approaching this in value per ton has since been found. You may readily imagine that the discovery of a mine containing ore yielding $4,000 per ton created an intense excitement among the enterprising men of California.

EXTENT OF THE MINING REGIONS.

This discovery marks a new era in the tide of Western immigration, when men whose westward progress had been stopped by the Pacific Ocean commenced to retrace their steps eastwardly, overspreading the vast area of country lying between the eastern base of the Rocky Mountains and the western base of the Sierra Nevadas. Here was a field well suited to the restless, adventurous spirit of the Western prospector; and so this immense stretch of country, embracing almost a million square miles, has within the last twenty years been traversed and prospected in every direction; and almost numberless mining camps have been established where not a mine was worked or even known at the time of the discovery of the Comstock lode, although several hundred thousand people, prior to that time, when on their way to California, had, to some extent, prospected this identical territory. Gold, silver, and also the useful metals seem to occur almost everywhere in these regions, although not always in paying quantities.

These explorations have disclosed what may be considered an unexplained fact, that the summit of the Sierra Nevada Mountains forms the dividing line of what may be termed the pure gold ores; that is to say, the pure gold ores are almost uniformly found west of the Sierra Nevadas, while silver ore in all varieties, though occasionally associated with more or less gold, is found to the eastward

BACKBONE OF AMERICA.

It appears that the backbone of the American continent, stretching from Cape Horn to the icy regions of the North, forms the great mineral store-house of the globe; and that portion lying within the boundaries of the United States constitutes one of the most important interests of this country. This interest should be fostered and developed; and permit me to say to you that your club, which has been properly styled the Bullion Club, will form an important factor in the development of this great source of wealth, by disseminating information, and by bringing together representative men from every section.

In this connection, I intended to have made some remarks upon the influence which the increased production of the precious metals and a bi-metallic currency have upon the prosperity of the commercial world; but I leave this subject to the abler hands of Judge Kelley, of Pennsylvania, who will, as I am informed, shortly address your club upon that subject. Permit me now, after these general remarks, to turn to the Comstock mines and the Sutro Tunnel.

THE COMSTOCK LODE.

The Comstock lode appears on the surface of a range of hills called the Washoe Mountains, lying to the east of the Sierra Nevadas, and running parallel therewith. The Comstock lode occurs mainly at the contact of two kinds of rock, and is, therefore, in fact, to a large extent, a contact vein, though in other parts, as at the north and south ends, it is surrounded by the same kind of country rock. The central portion of this mountain range is formed by Mount Davidson—a mountain rising to the height of something like 7,800 feet—and which consists of syenite; this is probably the oldest formation in that neighborhood. Immediately east, and, in fact, also west of the syenite of Mount Davidson, we find greenstone or porphyry, of which great varieties exist, which for convenience are called by the family name of propylite. Still farther east, we find the trachytic mountain range. There have been various theories advanced as to the origin of that lode, but there can be hardly a doubt that it is a true fissure vein. All the evidence tends to show that such is the fact.

FORMATION OF THE FISSURE.

According to Baron von Richthofen (who is probably one of the ablest geologists now living, and who has made a careful examination of the Comstock section of country, spending nearly two years there), the syenite is the oldest formation, the propylite or greenstone coming next in order, while the trachyte is the outburst which appeared at the latest geological period. If we examine the locality, we find, as already indicated, that the Comstock lode occurs mainly between the syenite and the propylite. The probability is, that when the trachyte made its appearance, the upheaval was so great that it uplifted a large portion of the greenstone. The effect of this upheaval was, that a fissure was formed at the plane of least resistance—that is, at the point of contact between the two rocks; large masses of country rock from the hanging-wall falling into the fissure, forming what we now call "horses," were the cause of keeping the fissure open. Had it not been for the fact of these masses falling into the fissure, it would, in all probability, have closed up again. But in this manner there was left an open channel down to an indefinite depth, which gradually became filled, probably by means of thermal agencies, or possibly by volatilization, according to the different theories which scientific men accept. These masses or horses must necessarily have fallen into the fissure from above; and, as a proof, we have the fact that in the Comstock lode every "horse" consists of greenstone, that being the upper rock; the syenite being at the bottom, none of it could have fallen into the lode. The open spaces thus left in the fissure were gradually filled, and the horses became surrounded by quartz and minerals, mainly silver ores, carrying more or less gold, which are sometimes accompanied by the base metals. I listened with great attention to the lecture which Professor Newberry delivered in this room last Thursday, in which he expressed the opinion that the particular fissure which he was describing had been filled in with ore by the process of deposits from thermal waters. It seems to be hardly probable that the Comstock lode was entirely filled in that way. It is probable that different processes were at work at different periods; and it is very likely that a portion of the vein matter which now fills that lode entered it by the process of volatilization.

VOLATILIZATION.

It seems difficult to imagine silver or gold in a gaseous form; but if you consider for a moment, it does not appear so strange. We know that all the substances of the entire globe exist in one of three forms: solid, liquid, or gaseous; while some substances are familiar to us in all three forms.

Take water, for instance: we know it as a solid when it is ice; we know it as a liquid ordinarily; and we know it as a gas in the form of vapor. We know all of the metals in two of these forms, as solids, and as liquids when molten. We know some of the metals in all three of the forms. In fact, in our laboratories, we can convert many solids into liquids by melting, and even into gases by volatilization. Now if we imagine the great laboratory of nature down in the bowels of the earth, where all the agencies probably exist which are necessary for reducing these various minerals to a gaseous state, the filling of fissure-veins with metals does not appear so difficult of explanation. We must try to realize the fact that in that laboratory of nature there may exist a pressure of millions of millions of pounds to the square inch, and that the steam which is there generated may be heated to white heat; that is, hot enough to melt iron or any other substance. If we imagine such a heat as that, we can readily perceive how any substance might be volatilized; and if to these two forces certain chemical agents are added, the transformation will seem still more probable. I doubt that a vein of the size of the Comstock lode would ever have entirely been filled by deposits from water.

DOWNWARD CONTINUANCE.

These theories may be correct or not, but we do absolutely

know that we here have a vein which lies between Mount Davidson, the syenitic mountain, and the propylite adjoining it, extending for a distance of four miles, and reaching downward as far as the miners have gone, and in all probability farther than mechanical means will ever permit man to go. There are obstacles in the way which will prevent an exploration to an indefinite depth. As far as the lode itself is concerned, we find that it retains its general characteristics at various depths; that it varies in width from fifty to one hundred and fifty feet; that it consists of solid quartz, interspersed with particles of ore; but that in many portions it is not sufficiently rich in ore to pay largely for extracting. It seems that the ore in the Comstock lode often occurs in the form of pockets, or channels, or chimneys, or, as we call them when we find a great body, "bonanzas." It is strange that, in the vein itself, a bonanza hardly ever occurs.

BONANZAS.

The lode descends on an incline eastwardly, following the dip of Mount Davidson; in places the pitch is greater than at others, but the average is about 45 degrees. The ore-bodies seem to occur outside and to the east of the vein; they are generally of a lenticular form. It frequently happens that, in sinking a shaft or in running a drift, no ore at all is found; a drift may run right over or under it; while the very next drift may show an ore body of great width. This accounts for the great fluctuations which have taken place in the stocks of the mining companies on the Comstock lode. People who are not familiar with the situation do not understand the reason for such fluctuations; but what I have stated will explain one of the causes. These ore bodies are not confined to any particular spot. The country to the east of the Comstock lode may contain ore-bodies to an almost indefinite extent. If we imagine, which I firmly believe, that the Comstock lode continues downward for miles, then it is possible that these ore-bodies may make their appearance at comparatively lesser depths, several thousand feet to the eastward of the present workings. The disposition of these ore-bodies is not governed by any rule. It seems to be entirely arbitrary. We do not know where they are until we stumble upon them. The only way to look for them is to run drifts all through the country, and then to cross cut from these every one hundred or two hundred feet. Some men say that the Comstock lode is working out. That is nonsense. Several deposits have been found which were of such immense value as to astonish everybody; but these bonanzas were limited in number—probably not over a dozen altogether; and they were always found in the manner I have described.

SINKING SHAFTS.

They first commenced the working of these mines by endeavoring to sink a shaft, on an incline, down into the lode itself. It was soon found that this was a poor way of mining. It was considered necessary to start shafts farther to the east. Accordingly, shafts were started which would cut the lode at a depth of seven or eight hundred feet; but they found that these shafts at that depth struck the rock of Mount Davidson, and, owing to the meager facilities which they then had for boring, they were obliged to give that up. They found it more profitable to start still other shafts farther east; and when these reached Mount Davidson rock, they were continued by inclines; lately, still other shafts were started so far east that they will not reach the lode until they have gone down to a depth of 3,000 feet; one of these shafts has lately been started on a gigantic scale, and so far east that it will not strike the west wall until it gets down to a depth of 4,000 feet. People look upon that as being rather an extreme undertaking. because the shaft will be so far away from the lode that they will have to drift, after it reaches a depth of 3,000 feet, still over 1,000 feet to get to the lode. So you see that it is not always advantageous to start a shaft so far away from the point designed to be reached.

STRENGTH OF CABLES.

During the past twenty years enormous sums have been spent on these mines. Probably, in no mines of the world that have been worked, has there been such a lavish expenditure for machinery, in order to secure every facility for the successful working of the mines. Such an expenditure was necessary. The work could not have been performed otherwise. The result has been that the mines have been more rapidly developed than any other mines ever worked. Of course, the difficulties in mining increase as we go down. In the first place, after you get down below 2,000 feet, the steel cables have to made of such a size (in order to sustain their own weight), that it becomes a very serious question whether they can be used in one length to much greater depth. This is a subject which has been discussed very fully in England and in Belgium; and the engineers there have come to the conclusion that it is not practicable to hoist with them after you get down over 2,500 feet; but the people on the Comstock lode say that they can go down over 3,000 feet and still use them. It is a question simply of the strength of material. These cables are made of fine steel wires, woven together. There certainly must be a limit to their capacity, even if they are made tapering. If the cable is long enough, it will certainly break of its own weight, and without the attachment to it of any additional weight. On the Comstock lode I do not think that this will cause any very great practical difficulty for several years to come; and before that difficulty does arise a new basis for hoisting work will have been utilized at the level of Sutro Tunnel, where they can start afresh.

WATER AND TEMPERATURE.

Another difficulty, and one of the greatest obstacles encountered in the working of these mines, is the presence of water, which is found in great quantities—and hot water at that. Gentlemen have different ideas about this water, and how it gets so hot. I have, from my own observations, formed my own ideas about it. I do not think, as is contended by many, that this water is heated by chemical decomposition. My theory is, that the water from rains and the melting snow upon the Sierra Nevada Mountains rapidly descends through the fissures of the crystalline rocks (and as they generally incline at a sharp angle, the water descends very rapidly), until it reaches a depth of several miles. We know (although by some it has been disputed) that the increase in heat is about one degree of Fahrenheit to every sixty feet of descent. I think that this has been demonstrated all over the world. Of course, there are instances where this is not the case; but those are the exceptions. On the Comstock lode this rule does not strictly apply, because the heat increases much faster as you descend. There, at the depth of 1,400 or 1,500 feet, the mercury rises to 110°; and at 2,500 feet, the temperature of the rock is as high as 130°; and at 2,800 or 3,000 feet, it is as high as 150°. I have observed this matter for many years, and have looked into it pretty closely, and my idea is, that this water descends from the Sierra Nevada Mountains to a depth of 10,000 to 15,000 feet; that it is there converted into steam, and finally into superheated steam. Of course, there is then exercised an upward pressure which does not permit any more water to descend, because the pressure of the descending water is counterbalanced by the pressure of the superheated steam. I recollect that I had, a few years ago, a controversy with Professor Sterry Hunt (probably the best-informed man on this subject in the United States) and some other gentlemen; and his idea was, that if there was so great a pressure down there, the steam would thereby be again converted into a liquid. But I do not think that bears upon my theory at all; because if the steam is reconverted into a liquid by the immense pressure, it would become steam again upon lessening or removing the pressure. If, therefore, the water descends until it becomes heated to a boiling point, it may then ascend, either because of capillary attraction or of pressure; and as it finds its way upward through the crevices of the rocks, it necessarily heats the rocks by the contact. And here it is where mistaken ideas come in; the rock does not heat the water at these higher points, but the water heats the rock. It seems to me quite evident that, as the water permeates all the cracks and fissures of the rock, the rock itself thus becomes heated. Of course the water loses some of its heat in its ascent. If we could go down 3,000 feet deeper than we now are, we should find boiling water. It is now 165° in some places.

At Steamboat, and in that immediate neighborhood, we find springs that are emitting great quantities of boiling water. On a direct line, these boiling springs are not over six or seven miles from the Comstock lode, and it is quite possible that these may be connected directly with that lode. The only difference between the hot water at the Comstock lode and that at the boiling springs is, that the water at Steamboat is somewhat sulphurous. Otherwise they are very much alike. That difference might be caused by the water passing over rocks containing sulphur.

LIMIT TO MINING.

Accordingly, the limit of mining on the Comstock lode will be reached when the mines get to a depth where it is so hot that human beings can not exist any longer. Some think that said point will be reached very soon, considering the rapidity with which the mines are worked. The fact is, that now, already, where the men are working in the lower levels, it seems almost impossible for a human being to exist. The men could not work in such a heat but for the fact that in the particular locality where they are swinging their picks a stream of compressed air, or cool air from a blower, is directed upon them; but as they go to and from that particular locality, they have to pass through places which are intensely heated, and in which they could not exist for any length of time. By means of such appliances, using very large blowers and powerful compressing machinery, I have no doubt that the men could work these mines even where they contain boiling hot water. If you show the people a big bonanza, they will devise some way of getting out the ore. The only trouble is, that at this great depth it takes so much longer to explore the mines that people get impatient. Where it formerly took only three months to explore a new level, it now takes six, nine, or twelve months. I believe that the Comstock lode can be successfully worked for thirty, forty, or fifty years to come below its present depth; and there is work enough above it to last for a hundred years to come.

MINING TUNNELS.

After these general remarks about the Comstock lode, I will now proceed to say a few words about the Sutro Tunnel. The idea of running a tunnel into a mountain for mining purposes is nothing new. It has been done ever since mining commenced. In Germany, where mining has been carried on largely, and also in Spain, and even in England, they have used tunnels quite extensively in connection with mining operations. In the Hartz Mountains, a great number of tunnels have been thus constructed. The topography of the country there is such that tunnels can be run to considerable depth, and they have been constructing tunnels for the last eight hundred years. At the end of the last century they constructed a tunnel 6½ miles in length; then, starting at a lower level, they constructed another tunnel, and so on, until finally a tunnel was completed, some twenty years ago, which had a length of 14 miles, and which reached three hundred feet below the level of the next deepest tunnel. In other parts of Germany and in Hungary we find the same thing.

THE SUTRO TUNNEL.

Fourteen or fifteen years ago, I proposed to run a tunnel into the Comstock lode, a distance of four miles. The people thought that it was an immense undertaking. Those who are interested in the mines would never have consented to contribute to such a work, for their interest is only of a temporary character; they calculate their profits from day to day, in the attempt to make a stock speculation. All such people care for is to make a "turn" in the stock, to sell at a high rate, and then they back the stock at a lower rate. In other words, the men owning shares in the mines were unwilling to give any portion of their earnings for the construction of a work which would not benefit them immediately; it troubled them but little what would become of the mines after some years. Their method of mining was a regular "grab" game. They looked for big bonanzas; they left the poor ore untouched and seemed unwilling to make any provision for the future which would enable them to work the lower grade of ore profitably. I did not, at that time, know much about these tunnels in Europe, but I saw that the construction of a tunnel to the Comstock lode was a common-sense proposition. I saw that it would be an immense benefit to run a tunnel reaching the mines at a depth of 1,700 feet. Many other people began to think so, too; they were finally convinced that it would be a good thing; but, instead of lending their aid and influence, and spending their money in the construction of the tunnel, they spent their money in fighting it. They spent more money in fighting the tunnel than we spent in constructing it; and they were beaten in the end. It was a question of millions. The opposition to it was persistent and powerful. The object was to get possession of the work for themselves. They were determined to oust us. Finally, they found that they could not continue the opposition any longer, and that it would be impossible to work the mines without the assistance of a tunnel; and so at last we came to an understanding all around. We commenced, last spring, to negotiate the terms of a new agreement. They were pretty stiff-necked about it, and so were we. We thought, as they had held back so long, and as they had to have the aid of our tunnel finally, that we were entitled to make fair and equitable terms. And thus it took about three months to negotiate an arrangement. At last we came to an understanding, which is looked upon as being a fair arrangement for all parties concerned. Under that the agreement which we had originally entered into with the mining companies was modified. Under the original agreement we had contracted not only to run a tunnel to the Comstock lode, a distance of four miles, but we were also to construct a tunnel along the Comstock tunnel for three or four miles more. A part of the settlement is, that we agreed to reduce our royalty on all ores yielding under forty dollars per ton, from two dollars to one dollar per ton, while all ores yielding above forty dollars still pay two dollars. They, on their part, agree to pay for these lateral tunnels in the form of a loan; but it is really no loan at all, for we pay no interest upon it, and it is not repayable except by deducting half the royalties that we earn. So, if a mine finds no ore, we are never to repay it. It is, therefore, not in the form of a debt. We are now engaged in constructing these lateral branches, and the mining companies pay us from $20,000 to $40,000 on the fifth day of every month, which fully pays for the work. We have, also, already commenced earning some royalty, though not a great deal as yet. We probably receive from $7,000 to $8,000 per month from that source; and as soon as the lateral tunnels are extended past each mine it commences to pay, and our royalties, therefore, will increase gradually. The production of the Comstock lode, at the present time, is very limited. The fact is, that during these pending difficulties they could not prospect their mines, and for three years they have hardly been doing anything. Since we have constructed the tunnel, and commenced carrying off the water which obstructed them, they have again begun to prepare for prospecting the mines. These preparations have occupied many months; they are now just about ready for a start; and I think that by the end of the year they will be able to prospect a number of the mines, and especially those that they call the water mines, such as the Savage and Hale & Norcross. From that time they will go right on prospecting and opening up the mines.

DIFFICULTIES IN TUNNELING.

In the construction of this tunnel we had a severe struggle to get along. On the one hand, we had these people opposing us, and on the other hand we encountered the difficulty of raising money sufficient to carry on the work, and that was about the "toughest job" of all. But still we succeeded. There were some gentlemen who took broad views of the matter, and partly through their influence and aid the money was forthcoming, and since then we got along reasonably well.

In one way and another we encountered many difficulties in doing the work. We had to work our way inch by inch through solid rock. In these tunneling operations, we have first to drill a dozen or twenty holes, charge them with giant-powder, explode the blast, then wait for the smoke of the powder to disappear before we can commence loading the *débris* on the cars for removal. Under the circumstances, one can not get ahead very fast; but altogether we made quite as rapid progress as has ever been made in any similar undertaking. In fact, our progress was more rapid than was the construction of the Hoosac, the Mont Cenis, the St. Gothard, or any other tunnel.

A CHAPTER ON MULES.

Up to the present time all the transportation has been done by means of mules. We found it more convenient to use mules than to use steam, because, under ground, steam is fatal to life. We are now preparing to use compressed air motors, built on the same plan as those in use on the Second avenue in this city. We have now two motors building in England. We have been using mules for years, and have found that they are tolerably good animals; but there is a prejudice against mules, though they are very intelligent. I think that I could write a chapter on their traits, as I have had a very extensive experience with them. It has been said that they have a strong propensity for kicking, but I have never seen them kick when in the tunnel. They become very tame under ground; in fact, they become the miners' pets. The men become quite attached to them; and as the shift-mules pass along by the men at lunch, they will often receive from one a piece of pie, and from another a cup of coffee, etc. When a signal is given to fire a blast, the mules understand the signal, and will try to get out of the way of it just as the men do. Of course, under ground is very dark, and the mules become so accustomed to the darkness that even when they go out into the sunlight they can not see very well, and when they go back from the sunlight into the mine, they cannot see at all. So we are in the habit of covering one eye with a piece of cloth whenever they go out, and keep the covering over the eye until they go into the tunnel again; we then remove the cloth, so they have one good eye to see with. We had to adopt this plan for preserving their sight, because the mule is so stubborn that he will not pull unless he can see his way ahead. We have found out another thing about mules. We tried horses at first, but we found that whenever anything touched the ears of a horse, he would throw up his head and break his skull against the overhanging rock; but if you touch a mule's ears, he drops his head. For that reason we could not use horses; we employed mules, and they have answered very well.

OBSTACLES TO PROGRESS.

In carrying on a work of this kind, we meet all sorts of difficulties. Now and then we would get indications of water. The men would put in a blast, and the water would pour out in a perfect torrent, and the men would have, at times, to quit temporarily to escape it, and wait until the water had subsided sufficiently, so that they could go to drilling again. Every now and then we would come to a clay, that would swell and cave so as to reduce our progress of 150 feet (and afterward with improved machinery of 300 feet) per month to less than 50 feet per month. Sometimes we could not keep the roof up. As soon as we would get started a little way in our work of excavation, the rock would yield, and hundreds of feet would come pressing down on the timbers with such force that it was almost impossible to resist it. The worst ground that we came to was the swelling ground. This is sometimes clay, and sometimes it is rock. The moment you dig into it, it swells out; and no matter what size of timbers you use, it will snap them off as if they were but matches. Nothing will resist it. You must let it swell. In one place the swelling was so great that the track swelled up a foot or two seven different times, and each time we had to cut it down. The timbers used are a post and a cap. The pressure on this cap would be so great that the post would be pressed through the cap in twenty-four hours—just as though the

cap were a piece of cheese. The only way to keep the timbers from breaking, in such ground, was to employ men to ease up the ground behind the timbers. That is to say, they would take away the rock or clay from behind the posts from time to time, until, after a year or so, the ground settles down to its natural state and does not swell any longer. We have very little trouble of that sort now; but I suppose that we shall encounter it every now and then as we go on with the lateral tunnels.

BAD AIR.

The greatest obstacle encountered by us was the heat and the poor air. Our last opening to the surface was at shaft No. 2, about 9,000 feet from the tunnel entrance. From there we had to go to the Comstock lode, a distance of 11,000 feet, without any natural air connection. After we got in to a distance of 17,000 feet from the mouth of the tunnel, the heat became so intense and the air so bad that it was almost impossible to keep the air sufficiently cool and pure to sustain life. There was not oxygen enough in the air to make our candles burn. Although we blew in air by means of blowers and air-compressors, still at times there was not sufficient air to enable the men to work. In the place where the men were at work we could generally manage to keep the air sufficiently pure; but at some distance back from the face of the tunnel the air was so bad that one could hardly exist. In fact, in going through these portions of the tunnel, the men would often give out; and as for the mules, we could not get them there at all. A mule would make straight for the air-pipe, and you could not get him away. We had one mule that would not go away from the air-pipe at all. They beat him, but it was of no use. He had to be carried out, and that mule escaped. He never went into the tunnel again. A shift mule would always want to go to where the stream of air was rushing in, and he would monopolize it all to himself. He would never leave it, but would stand there, and as he bobbed his head up and down past the pipe, you would hear the air whistling by him.

ACCIDENTS.

We had some sad accidents happen. These air-pipes are made of galvanized iron, and the leakage is prevented by wrapping the joints with canvas which is covered with tar or with white-lead. I recollect that one day after a blast had been fired, one Garnett, the man whose duty it was to keep these joints wrapped, went forward (he was nearly fainting) to the end of the air-pipe near the face of the tunnel; but before he got there, he fell down in a swoon. When the blaster went forward to examine the blast which had just been made, he found that two of the holes had not gone off, and so he re-connected them and fired the blast while this poor man was lying on the ground. It did not kill him, although he was riddled with rocks. He had about a hundred large and small pieces of rock in him, one being in the back of his head. I thought that he could not live for ten minutes; but he is alive now and as well as ever. The most curious part of it is that for a long time previous this man had been in ill-health, and that application of rocks cured him. He has told me often, since, "That confounded thing cured me." It was rather a severe cure, but it was effectual.

As we approached shaft No. 2, 9,000 feet from the tunnel entrance, which had been abandoned some time previous because it had filled by a great influx of water to the depth of about 900 feet, we bored a diamond drill hole into it, and the pressure of that column of water, 900 feet high, was so great that it threw out the drill-rod and cast it a distance of several hundred feet, although the rod weighed several hundred pounds.

CAVES.

Not long ago some timbers broke down, and the report came to me that a man had been killed. We found, however, that he was not injured, but that he had been caved on and could not get out. I started in with the doctor to see how he was getting on. We found that all the work had stopped, and that the man, who had been working in the ditch which we were then constructing in the floor of the tunnel for the purpose of carrying off the hot water, had been caved on and become surrounded by a lot of loose, fine gravel, up to his chest, and that the water running in around this gravel had packed it so tightly that the man could not move. We had to get him out in some way, and so three or four men (which were as many as could get into the confined space) got down alongside of him and tried to dig him out; but, as fast as they would dig, the gravel would cave in again. When I reached the place the man had been fast for three or four hours. The miners had built dams above in the tunnel to stop the water from flowing down; for, if the water had been permitted to come down, it would soon have risen to his mouth, and would have drowned him. He was so fast that he could only move the upper part of his body a little. I urged the men to work away with all their might at the dam to keep the water back; but after a while they reported that it was of no use, that the water was rising above the dam. We did not want to see the man killed, and used every effort to rescue him. I told the men to pass a rope under his legs and try to pull him out. We thought we had better pull him out, even if it should injure him somewhat, rather than let him drown; but as soon as we began to pull, he commenced to cry out, so that we had to give that plan up. Then the men dug again for a while, until the foreman came and said that if we did not get him out within ten minutes, the water would be down in such volume as to drown him. Then the men worked again with the rope for dear life; at last they got one leg out, then they gave another jerk, and brought the man out.

HOSPITAL.

As I have remarked, we employ a surgeon. There were many accidents, although we had less than there were in other works. In the Hoosac Tunnel, 185 men were killed in the construction of the work. In our tunnel, but 12 men were killed, and I do not think that of the 12 more than three or four were killed by anything actually happening in the tunnel itself. I told our men several years ago, that every man employed by the company must pay three dollars per month toward a hospital fund; that the company could not afford to give the men all the attention that they ought to receive in case of accidents. The men remonstrated a good deal against this; they did not wish to spend their money in that way; each one thought that no accidents would happen to himself; but I made this payment compulsory, and after a while the men became reconciled to it.

We employed a physician and opened a drug store. If a man was injured he received every attention. He had the care of nurses, physicians, and medicine. But these miners are all members of an association, the Miners' Union, which does not permit any man to work a shift of eight hours under four dollars per day. All the mine managers have agreed to yield to their wishes, and I think a man working in these hot places well earns his four dollars. But sometimes the union will interfere with us where they should not. They sent a deputation to me not long ago, to say that we were not paying our men four dollars per day. I said that we were. They said that we deducted three dollars per month for the hospital, and that therefore the men only received one hundred and twenty-seven dollars per month, which was not four dollars per day. I replied that that was for the benefit of the men themselves; that it was a work of benevolence; that I had inaugurated it solely for the benefit of the men. They insisted that the men should not be compelled to pay anything to that fund; and as we had to complete a certain amount of work at a given time, and could not afford to get into any trouble with the men, we had to yield in this matter.

STARTING A GRAVEYARD.

One labors under all sorts of difficulties in dealing with the men. It seems ridiculous; but the most difficult thing we had to do was to start a graveyard. It took some three years to start it. Whenever a man got killed or died, the men would get up a big funeral, and go off to Virginia City or some other place to bury the man. All work had to be stopped for one or two shifts. They would each lose their $4.00 for wages; would pay $300 or $400 more for teams; and some would drink so freely as to be unfit for work the following day. I was determined to put a stop to that. So said I to the men: "Why can we not have a graveyard of our own and bury our men here? I had a grave dug for the next man that died. The dead man's friends came and said they would not have the man buried there. I asked them why? They said that "it would be too lonely for the poor fellow." That seems ridiculous, but it is a fact. I did not wish to have any trouble over the matter, and so I let them bury the man where they chose. Every time a man died, we had just the same trouble again. At last two miners got killed who had not paid their fees to the Miners' Union, and had been discarded. They had no friends there to object, and so we buried them there, and thus were able at last to start our own graveyard.

ADVANTAGES OF THE SUTRO TUNNEL.

But, gentlemen, I fear that I am detaining you too long with these outside matters, and will now proceed to speak about the advantages of the Sutro Tunnel itself. The first great advantage of the Sutro Tunnel is, that it creates a new base of operations. We open a new surface for mining operations—a surface which is in fact a better surface than the original one. We are down 1,700 feet from the surface, and can introduce water through the shafts, and thus get a fall of 1,700 feet; or we can take the water which exists at some point between the surface and the tunnel and let it flow down to run the machinery which is placed at the tunnel level. We thus could get an abundant water-power. A very small stream of water with a pressure of 1,700 feet will give an immense power. The time will come in the working of these mines when they will economize all of the water. In fact, the water which is brought in pipes from the Sierra Nevada Mountains can be most profitably used for that purpose; and the time will come when it will be so used extensively. You can readily perceive that a new surface at that point adds just so much to the working possibility of the Comstock lode.

The lode extends down indefinitely, and the ore bodies recur at different places; we cannot tell exactly how or where, because their distribution seems not to be governed by any known law. The tunnel adds to the working possibility of that lode certainly 1,640 feet, which is the level at the point where the Savage shaft is intercepted by our tunnel, and that shaft is away down the hill. That is, of course, an incalculable advantage; for those 1,640 feet are surely added to the working possibility of the Comstock lode, and ought to be worth to it a great many millions of dollars, perhaps hundreds of millions. The Comstock lode has already yielded something like $400,000,000, and there is in it an enormous quantity of low-grade ore which has not been taken out.

DRAINAGE.

The next important advantage secured by the tunnel is that we carry off the water. Instead of pumping this immense body of water to the surface, it is pumped into our tunnel, which saves 1,640 feet of pumping. When I last left the work there were running out about 12,000 tons of water every twenty-four hours. To lift this water to the surface, estimating it at a very low rate—indeed, at much less than it actually costs, say at 25 cents per ton, it would cost $3,000 per day to pump it out to the surface. In order to carry off this volume of water (and we agreed to take the water within ninety days from the time we made the settlement with the mining companies), we had to provide the means. Some of this water has a temperature of 165°; some has a lower temperature; where it is all mixed together it is about 130° or 135°. If we were to let this water flow through the open tunnel, a distance of four miles, the heat would be so great that we could use the tunnel for no other purpose; the steam would suffocate the men. We were therefore compelled to construct a drain, and to place a wooden box in this drain. We had quite a controversy over the way this drainage should be effected. Every man had his own ideas as to the best way; each engineer thought that he knew all about it. I contended that if we were to construct a wooden flume, perfectly tight, of 3 inch yellow pine, we should be able to carry off the water and not radiate much heat from it. Others disputed it. I had machinery built for planing, tonguing, and grooving this yellow pine, and which cut it off, all in the same operation, so that the construction of this box was done at a very reasonable cost. We placed these boxes and joined them together with slips of iron ½ by 1½ inch, which were driven into the ends of the boxes, and it made a continuous box so perfectly tight that when the covers (which were also tongued and grooved) were nailed on, and the water was turned in, there was not a leak from one end of the tunnel to the other; and, to the utter astonishment of everybody, the temperature of the tunnel has not been increased materially by the passage of the hot water through it; and the water, which was at 130° on entering the box, after flowing the four miles still has a temperature of 123°, having lost only 7° of heat in the passage. After it gets to the mouth of the tunnel the water is conducted down a shaft in the machine shop, where we have a water wheel placed at the bottom of the shaft 60 feet in depth. From thence the water is carried off by a tunnel, 1,100 feet in length, which serves as a tail race. From this small tunnel the water flows about a mile and a half to the Carson River. This water can now be used for many purposes. The first who utilized it were the boys, who made small ponds to swim in at the lower end of the town. It can be turned to account in heating hot houses. We have a rich soil there, which, if covered over by glass, will produce early vegetables and fruit at very little cost. We use this water first for power and then for irrigation.

FARMING.

We have quite a farm belonging to the company, which will become very profitable indeed. The company owns over five thousand acres of land. The soil is very fertile, and all that is needed to make it highly productive is water. The water from the Comstock lode is particularly well adapted for irrigation, because it contains in solution sulphate of lime or gypsum, which is of itself a valuable addition to the soil, although that land is now so rich that it does not need any fertilization whatever.

VENTILATION.

The tunnel will also be of great advantage for the purpose of ventilation, not so much, however, by the air going four miles directly through the tunnel; for we find that does not answer so well as to use the air in the lateral tunnels by connecting every shaft with the other shafts. By that means we get a draught of air from shaft to shaft that is wonderful. Not long ago we were laboring under a great difficulty in the south header of the tunnel which was not ventilated. In fact, for three months we could not do anything. The men in these heated places are taken with "cramps," as they call it. We really did not know what the difficulty was, until one day a mule died while in there, and I had the surgeon hold a post-mortem examination on it. He found every organ perfectly sound, until he came to his lungs, which were found to be congested with blood. We can carry ventilation down the shafts as deep as they may go; and this fact will make it possible to work the mines at much greater depths than they have yet been worked. The great volume of air going through a shaft causes an evaporation of moisture which covers the sides of the shaft, and in that way lessens the temperature. Up to lately it was so hot in the north header that the men could not do a full day's work; but about two weeks ago we made the connection by a drift with a shaft, and now the air there is delightful, and our men are doing double the work that they did before. This shows how much depends upon a proper system of ventilation. It is worth millions to the mines. When the temperature is so high and the air so impure as it usually is in the mines, the men cannot do much work; in the hottest places it takes six or eight men to do a day's work; a man can only work five minutes at a time, and then he must retire to a cooling station; but if you give the men good cool air, they can do a day's work.

LOW-GRADE ORE.

Another very important thing in connection with our tunnel is the fact that it will make possible the extraction of the enormous body of low-grade ore in the Comstock lode. As I have already said, $400,000,000 have been extracted from the different bonanzas. People speculate in mining shares to make a fortune, and they want to make it overnight; and in searching for these bonanzas they have passed by the low-grade ores, because they thought they would not pay, or would pay so little as to amount to nothing worth the effort required. By means of our tunnel we can transport the ore to the mouth for one cent per ton per mile, which is as cheaply as the best-regulated surface railroad can do a similar work. We can afford to take these ores out and reduce them at the mouth of the tunnel. We have not yet commenced doing this; it has taken so much money for other purposes that we have not been able to do anything yet with the low-grade ores; but the time is coming when we shall be able to utilize them. Suppose that we are able to work 1,000 tons per day, which would not be considered very heavy work on the Comstock lode; that would give at least $2 or $3 per ton profit. They are willing to sell the ore to us at $1 per ton. We have established a scale of prices by which we are to pay $1 per ton for ore which yields under $15 per ton. But rock that yields $15 to the ton will assay a good deal more. Everything that we can get out of it is so much clear gain to the world; for under the old system they can never utilize these low-grade ores. I think there are $300,000,000 or $400,000,000 to be extracted from these ores now in sight in the 200 miles of drifts on the lode—enough to last for a hundred years' steady work.

CHEAP FIREWOOD.

There are other sources of revenue that the Sutro Tunnel Company will have. The Carson River, which flows within a mile and a half of the tunnel entrance, has its rise in the Sierra Nevada Mountains. There is wood enough there to last for many years, which can be floated down for less than $5.50 per cord. We can, by contracting therefor, a season in advance, get our wood there for less than $5; it is worth in Virginia City $10 per cord, and they often get $12, and the consumption is 600 cords per day. It will not cost us over $1.50 to deliver it at Virginia City. There is also a profit to be made from the sale of timber.

ICE.

There is another article which may be made remunerative, and that is ice, which is used in these mines to an extent which is really marvelous. The quantity of ice water that a man working in the mine will drink would astonish you. You know what you can do in that way when taking a Turkish bath; but they can discount that several times over. They drink it by the gallon. The men will rub ice all over their bodies, and it does not make them feel chilly. They get so heated that the ice feels comfortable to the body. When the surveying engineers go into the mines they have to take with them big sacks of ice to rub their heads and bodies, or else they could do no work. I cannot state the number of tons per day used at the mines; but there is more ice used there than there is in the whole city of San Francisco. It sells there for $30 per ton. Certain parties largely monopolize the ice business there; but some of the mining companies are ready to take ice from us. We can make it for fifty cents per ton. It freezes from six to fifteen inches thick every winter. We shall have a tram road down to the river, propelled by water power, over which we can haul up wood, timber, and ice. That will be a great advantage in connection with the working of these mines.

ROYALTY.

I will refer, in conclusion, to the royalty to which we are entitled. Before the settlement made last spring we were entitled to a royalty of $2 per ton for every ton of ore taken from the mines in all future time. Whether it was taken through the tunnel or not, they were to pay us $2 per ton. We, however, partly yielded our rights, and agreed to take

$1 per ton for all ore that yields under $40 per ton, and for all ore that yields over $40 the old rate of $2 per ton was retained. As the lateral tunnels progress our revenue will increase. I think that the royalty alone will in the end amount to $100,000 per month.

We have another source of revenue, from the transportation of men and ores. The royalty is received for draining the mines. We receive that without doing any further service. For the transportation of ore and men we will make additional charges. On ore or rock we are entitled to charge 25 cents per ton per mile. Negotiations are now pending for opening some of the mines east of the Comstock, and the people will want to go to work through the tunnel and to take their ore out through it.

MINERAL LAND GRANT.

I think that the most important possession of the Sutro Tunnel is its mineral grant. Under the Act of Congress of 1866, there was given to the Tunnel Company a strip of mineral land 2,000 feet in width on each side of the tunnel, forming the very heart of the Comstock country. The tunnel runs at right angles with the Comstock lode, which it reaches in a distance of four miles. After passing the Comstock lode we may go still three miles farther, through Mount Davidson, and beyond it. As far as this strip of land is concerned, we have discovered and opened several large ledges. We have cut one vein 120 feet thick, and we have just commenced to prospect it. We have run into it on one side—that is to say, we prospect the vein for a width of 4 feet, which is the size of the drift. That does not explore the vein. After we get in a certain distance we propose to cross-cut it at given intervals. We get assays of that ore varying from $2 to $43 per ton. There is no body of it that will assay at that rate; it is only in spots that it will do it. These veins are all of the same nature as the Comstock lode. We may here come across as big a bonanza as has ever been found on the Comstock lode. These veins were probably all formed at the same time, and they may all unite somewhere; but we can never get to that point, as it is probably two or three miles down. Under the Act of Congress, we are entitled to all the mineral deposits we find on that grant, which were not owned in 1866, and worked according to the mining laws. The Comstock lode is, by words, specifically excepted; so that, of course, we have no claim to any part of it; but the Comstock mines have to pay their contributions for benefits derived.

To the other veins I think we have a pretty clear title, with the possible exception of one or two mines, which the companies claim to have possessed and held before this act was passed.

So far as our grant of land beyond the Comstock lode is concerned, I think it will before long be prospected by continuing the tunnel beyond its present end. We have to cut through the syenitic mountain, which nobody else could ever pierce. People there think that there are no mineral veins in the syenite.

MOUNT DAVIDSON.

I have visited many of the mining districts of Europe, and I found that at Schemnitz, in Hungary, there is precisely the same formation as at the Comstock lode. I have mingled specimens of the country rock from the two places, and I have never found anybody in Nevada who could tell them apart. We have the syenite there, as well as the greenstone and the trachyte. We find at Schemnitz half a dozen veins in the syenite that have been worked for a long time. We know that there are outcrops on Mount Davidson which show well in metal. They have not gone into Mount Davidson, because they have been afraid of striking water. We do not care how much water we strike, for it will flow off through the tunnel. The water all comes from that side, from the Sierra Nevada Mountains. They have not gone into that mountain because they were afraid of being drowned out, and also because the rock is so hard that the men say they can never get through it. I think that in this respect they are mistaken. We have never yet seen any rock that we could not go through with a 5-inch percussion drill. With it we can strike a blow of 1,000 pounds, at the rate of 300 per minute, which will drive the drill through almost anything. But we are not yet prepared to go into Mount Davidson. It will take considerable money to do so, and we have a use for all the money we have at present. The time will come before long when we will go ahead with that.

The same formation existing east of the Comstock lode also occurs beyond Mount Davidson. We there find the same propylite, with specimens of gold, on the surface, although there is no well-defined ledge. But you cannot tell anything about these outcroppings until you get down to a considerable depth, for the surface is all covered over with *débris*. You may find ore there, and you may not. You may find a chimney there. It is a mistaken idea to suppose that, because you find a vein of ore, you may be able to dig out the whole vein. The ore occurs in all mineral veins, in zones, chimneys, and spots. There is always some uncertainty in working a mine. You may explore and find a good showing of ore, but you cannot tell how far the ore goes. Experience teaches us that this is uncertain. But the ore does occur in zones, and you may have to dig a long distance through the vein before you find another zone.

LONGEVITY OF MINING DISTRICTS.

But if you take a whole mineral district you will find that there is a most extraordinary permanency about the aggregate yield. History tells us that the mines of Cornwall have been worked for over three thousand years, and they are being worked to this day, and the yield still is very considerable. The same is true of the mineral deposits of the Hartz Mountains. The mines there have been yielding for over eight hundred years. The same is true of the district of Freiberg. That has also been worked for centuries, and it still furnishes a good yield.

If you take the district of Schemnitz, you find that it is the same. If you go into Mexico, you find that the mines of the Veta Madre, of Guanajato, have yielded over $800,000,000, and are yielding still. If they were to put up proper works there, they could continue to work those mines for centuries to come. There is a chance for an enterprising man to go and dig a tunnel into those mines. I do not, myself, want to dig any more tunnels; it takes too long a time. So, too, the mines of the Veta Grande, of Zacatecas, are yielding still four or five millions per year, though they have been worked almost since the discovery of America.

I consider that an enterprise like the Sutro Tunnel, based as it is upon the results obtained in a whole mining district, furnishes one of the most promising and surest investments in the world. It may take time to realize, but it is sure. These every-day ventures are gone into by everybody, and, as a result, there is only a little money to divide.

SECURITY OF TITLE.

Under the Act of Congress we are given certain rights. At that time the United States was the sole owner of these lands. At the time of the passage of the Sutro Tunnel Act the government owned in fee all the mineral lands in the West. Shortly after that time a general law was passed, giving a title to any man under certain conditions who wants to purchase mineral lands. Immediately succeeding the Sutro Tunnel Act, this general act was passed. But our act has the precedence over all others, and our title is better than the title of anybody else holding mineral lands; for ours is the first act and the first grant of mineral lands made by the Government of the United States since its organization.

The cost of the Sutro Tunnel thus far has been about $3,800,000. That is according to the last balance sheet, and is exclusive of interest. Adding the interest, it would figure up about three millions more during ten years. So I estimate the total cost of the tunnel to be about $7,000,000.

I have taken up your time much longer than I intended. I could go into other phases of the history of the tunnel, but it would take entirely too long.

The above address was delivered November 6, 1879. Mr. Sutro was listened to with close attention, and at the conclusion of his remarks the Club tendered him a vote of thanks.

SHAFTING, COUPLINGS, AND HANGERS.*

Shaft-bearing. Fig. 1, A, clamp-block.

B, pillow-block resting on cast iron wall plate, *a*, and provided with oil dish, *b*.

C, the same inverted; used for carrying the head-shafts of long lines of shafting.

D, the same built into a wall and protected by an arched wall box, *c*.

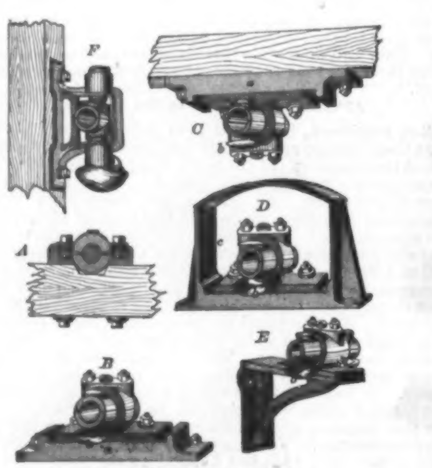


Fig. 1.—PILLOW-BLOCKS.

E, pillow-block secured to a knee, *d*, attached to the face of a wall. *b*, oil dish.

F, post-hanger fastened to an upright or pillar. See also Step; Spindle.

Shaft-coupling. 1. A device for connecting together two or more lengths of a revolving shaft by shaping the ends into flat surfaces or bearings, which are held together by a strong iron bush or coupling box.

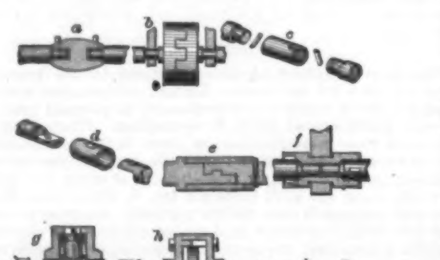


Fig. 2.—COUPLINGS.

A common but unyielding coupling, *a* (Fig. 2), is formed by fitting and fastening the square ends of the sections of coupling into sockets in an iron block.

Another mode, *b*, which admits of some yielding when the shafting is not perfectly in line, consists of serrated disks on the adjacent ends of the sections of shafting. These have sufficient play to permit the joint to bend a little when the shafting is out of line.

A form of coupling, *c*, consists of a cylindrical box with pins at right angle engaging the ends of the sections of shafting. By allowing a little play to the parts, this partakes in a degree of the principle of the *gimbal*.

The lap-joint coupling, *d*, is formed by reducing the ends of the shafting to a semi-cylindrical form, so as unitedly to form a cylinder, which is inclosed by a coupling sleeve secured by a pin or key.

By scarfing the ends together, *e*, they are protected against longitudinal displacement, without depending on the strength of the pin.

Murray's coupling box, *f*, rests in the hanger, and has sockets at the ends for the reception of the ends of the shafting and the keys, which are at right angles to each other. A slight play is allowed in the fitting of the parts.

In another form of coupling, *g*, a cross is interposed between the boxes, which are at the end of each section of the shaft. Each arm of the cross has a screw at its end; two of these receive motion from two projections on one box, while the other two bear against two similar projections on the other box, causing the two shaft sections to turn together. This coupling performs to a limited extent the function of a universal joint, but requires a bearing at each end of every section.

One form of friction coupling, *h*, consists of a pair of boxes, inclosing disks on the ends of the adjacent sections of shafting. Between the disks is a planchet of leather, which is compressed to such an extent by screwing up the bolts, as to cause the motion of one shaft to be communicated to the other. If a violent strain occur beyond the coupling, greater than that for which the coupling is intended, one of the disks will slip on the leather.

Mattison's friction coupling has caoutchouc on the abutting faces of the wheels on the respective sections of shafting. The frictional contact of the India-rubber when the wheels are brought into contact, causes them to revolve together when motion is imparted to one of them.

i. Hawkins. T-headed keys occupy longitudinal slots in the abutting ends of the shafts, and are held in place by a sleeve.

j. Wheeler. A ball on one shaft enters a socket on the end of the other, and is held there by a key passing through a slot in the ball and retained in place by a cap, allowing a certain degree of rolling motion.

k. Fox. The ends of the shafts are made tapering, are inserted within the tubular coupling, and held by keys.

l. Lecky. The end of one shaft has a screw-threaded tenon of peculiar shape, which enters a correspondingly threaded cavity in the enlarged end of the other.

m. Lecky. Is similar in general to the foregoing, but the screw-threads are flat on the sides which have to resist a pulling force.

n. Briggs. This coupling has an opening on one side, permitting it to expand somewhat to readily receive the shafts, upon which it is compressed by bolts and nuts; a recess on the opposite side receives one half of a key, fitting counterpart slots in the ends of the two shafts to compel their simultaneous rotation.

o. Bolles. Is particularly designed for well or other tubular shafting. The ends of each tube are threaded both internally and externally; the former threading receives an internal thimble connecting the sections, and the latter an exterior nut which covers the joint.

p. Gray. Two or more pawls within a sleeve are, by means of binding screws, pressed into nicks in the shafts so as to prevent their independent rotation.

q. Baum. A coupling fin provided with studs enters slots in the two sections of the shaft, and is retained in place by a sleeve held to the sections by screws.

r. Ruggles. The coupling box is in two parts, which are drawn together by a bolt having differential screw-threads adapted to corresponding internal threads in each half of the box between which the shaft is clamped.

s. Light. The ends of the shaft sections are slotted to receive a key which is held by a split sleeve secured by a nut screwed on to each of its ends.

Shafting. (*Machinery*.) The principal means in a machine shop for the transmission of power. It serves to convey the force which is generated in the engine to the different working machines, for which purpose it is provided with drums and belts, or else cog-wheels firmly keyed on.

Horizontal shafts are known as *lying;* vertical, as *upright*. Their *stiffness* resists *flexure* and *torsion;* their *strength* resists *fracture*. The *stress* is the power tending to break them.

A, Fig. 3, represents a portion of a line of shafting attached to beams of a ceiling. The hangers, *a*, are secured to the beams by bolts, and are provided with swivel boxes, *b*, facilitating adjustment and keeping of the shafting in line. These are adjustable in height by bolts and nuts. *c* are oil-drip cups, *d* a pulley, and *e* the coupling which unites two lengths of the shaft. These are shown in contact, but disconnected at B. C C are inside and outside views of the coupling proper. D, one half of the coupling, with its appendages complete. E E are the *thimbles*, and F F the securing nuts. The cylindrical interior of the coupling is bored with a *shim* between the two sections, so as to allow something for compression or hug. These are placed over the butting ends of the shaft sections, and secured thereto by pins, if desirable; the thimbles or cone rings are slipped over them, and the nuts, F F, screwed on with a spanner, binding the whole together.

In Fig. 4, A shows another pattern of shafting, with hangers and appurtenances. The journal box, *a*, is held between two pintles or stems, *b c*, the ends of which are concave, those of the box bearing being convex, so as to form a species of ball and socket joint, and allow the box to adjust itself to the alignment of the shaft.

The box is self-lubricating; the oil, after being drawn up from a reservoir below by the rotation of the shaft, and performing its office, is again returned to the reservoir, the drip cup being dispensed with.

Fig. 5 is a cast iron plummer block; it is lined with gun metal or Babbitt metal, and supported on a wall plate having snugs between which the block fits, and is adjusted in line with the shaft by cotters driven between its ends and the snugs.

Fig. 6 is a form of flexible shafting, avoiding the use of gearing.

It sometimes becomes necessary to take down a section of shafting, drive out keys and remove couplings, merely to slip on a pulley. To obviate this necessity, pulleys have been made in sections to be keyed together on the shafting.

Preferable to this is an arrangement by which a small section of hub and rim are made removable.

* From Knight's Mechanical Dictionary. H. O. Houghton & Co., publishers, New York and Boston.

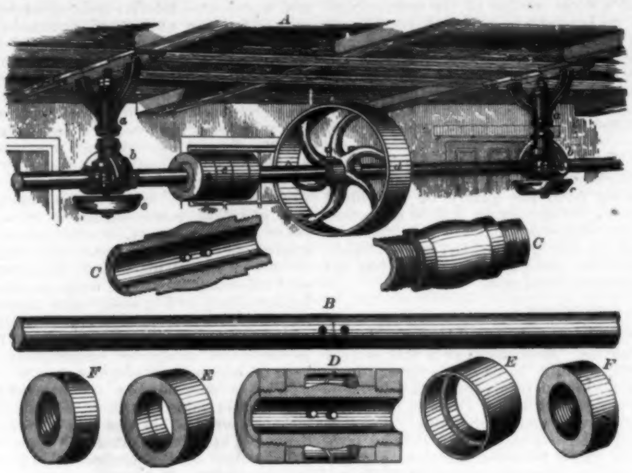


FIG. 3.—SHAFTING.

In Wheeler's (C, Fig. 4), one or more of the arms of the pulley are enlarged or divided, admitting a piece shown at *a*, a casting separate from the pulley, and easily fitted to the latter by the file. This supplementary piece has a section of the hub embracing one half of the shaft. It engages with the rim of the pulley by a parallel cut, divided in the center at right angles. This form of division, however, is not material. The piece is held in place by a bar, *b*, passing through the true arms of the pulley and the false arms of the segment, and held in place securely by a set-screw, *c*. Instead of this arrangement the bar may be a single key without set-screw. There is no set-screw to mar the shaft,

FIG. 4.—SHAFTING.

and no key in the hub of the pulley or keyway on the shaft to be cut. Most of the fitting required is at the rim, as the hub portion may be cast accurately enough and the key may be forged to fit.

FIG. 5.—PLUMMER-BLOCK.

Shafting-box. An inclosed bearing for a shaft. In the example, the shaft has its bearing in a perforated box within an outer shell filled with oil.

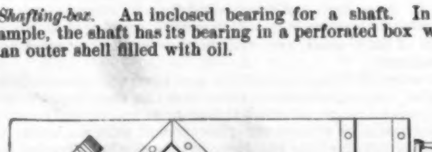


FIG. 6.—UNIVERSAL SHAFTING.

Shafting-hanger. A suspended bearer for a shaft. In the example, the body of the hanger is made hollow, and cores of different sizes are used in the space, so that one pattern may be used for several sizes of shafts. A self-oiling ap-

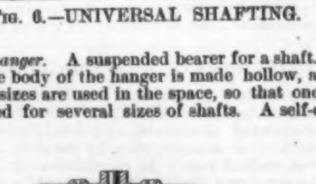


FIG. 7.—SHAFTING-BOX.

paratus is combined with a ball and socket hanger, so as to bring the reservoir of oil close to the lower side of the shaft and at the same time in the center of the bearing.

Shaft-straightener. A machine for rolling rods for shafting to take the bend out of them. The shaft is fed longi-

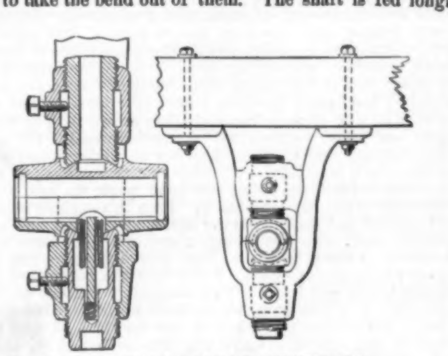


FIG. 8.—HANGER FOR SHAFTING.

tudinally between the pressure rollers, B B, which are geared to a common wheel so as to have rotation in the same

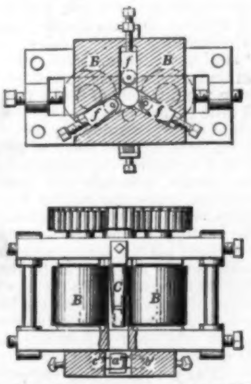


FIG. 9.—MACHINE FOR STRAIGHTENING AND ROUNDING SHAFTING.

direction. The feed rollers are upon the ends of adjustable slides, and are placed obliquely to cause the feed.

[Continued from SUPPLEMENT No. 204.]

MACHINERY FROM AN INSURANCE POINT OF VIEW.

By A. J. WATERS.

BELTING.

How long will a belt wear? is almost synonymous in its infiniteness with the query, How large is a piece of chalk? There are so many "conditions, limitations, and requirements"—to keep within insurance language—entering into the solution of this question, that a mere knowledge of one or two will hardly produce a satisfactory result. Among the elements entering into belt depreciation may be mentioned length, width, and thickness, speed, friction, or transmission of power, tension, proper adjustment, and temperature. If the belt is of leather, and oak tanned, it will last one-third longer than a chemical tanned. The manner in which belting is laced or joined together makes a great difference in the wear. Having each end of the pieces to be joined cut off true and square, and laced not too tightly, the wear of the belt may be decreased 2 per cent. per year. Some of the methods used to prevent a belt slipping on the pulley are detrimental to its wear, among which may be mentioned powdered rosin or pitch, which soon penetrates the leather and rots the belt. Roughing the surface by filing is another source of wear. Running the belt on too tight a pulley will generally heat, decompose the oil and organic matter of the belt, and hasten decay. A belt of unequal thickness will not only run badly, but wear much faster than one of equal thickness throughout.

Rubber belts depreciate faster than leather—frequently a few minutes of quick motion will roll the gum off in such quantities as to entirely destroy the belt. During freezing weather, if moisture finds its way into the seams or between the different layers of canvas in rubber belts and become frozen, the layers soon tear apart and the belt is ruined. Again, if they are used for cross-belts, shifting belts, on cone pulleys, or any place where they are liable to slip, friction soon destroys them. Using leather belts in damp places, or where steam comes in contact with them, materially hastens depreciation. As an illustration of the variation of depreciation in belting, we may mention the large driving belt of a thrashing machine—which will only wear a couple of years—and then compare it with the 36-inch driving belt of the Dayton Car Works—which has run continuously for ten years, and is virtually as good to-day as when first started. Short driving belts depreciate more rapidly than any other, and need to be replaced every ten or twelve months. Generally an eight to sixteen inch belt will wear from six to eight years.

Taking all the facts into consideration, and the entire amount of belting used, a fair depreciation would be: Flouring mills, 10 per cent.; iron workers, 12½ per cent.; and wood workers, 20 per cent. Belts in contact with steam or moisture will depreciate 10 per cent. faster than when run in a dry place. The cost of belting may be had from the dealers' catalogue—from the prices of which there is a discount of from 40 to 50 per cent., and sometimes a small discount off that for cash. The belting of a shop is a good criterion by which to judge of the value of the machinery of the shop. A person not a machinist might be bothered to tell whether the machinery of a shop was in good condition, or whether the business was profitable. These doubts can be materially lessened by a glance at the belting. If the general make-up is bad—if the belts are all patched, frayed out, or badly doubled at the edges, and have a sort of thrown-together look, or if there is a deal of wabbling on the pulleys, and a sort of general shabbiness throughout—it can be safely set down that the concern is hard up, or the machinery is badly worn—that there is a scarcity of work, and, in all and singular, this little index pretty surely points to the fact that your particular company don't want that risk.

FLOURING MILLS.

The number and style of these are almost legion, from the old water mill on the creek, where in our boyhood days we took our first lessons in machinery, and cultivated the gift of patience while waiting for the grist, to the magnificent brick edifices, with all the modern improvements of separators, bran-dusters, middlings purifiers, and hazardous elements of a powder mill, distance seems almost inconceivable, and yet the march of improvement has traversed the distance, and the insurance companies have paid for the passage. While the work of progress is on nearly every part of the machinery of a mill, one old landmark yet remains. The "upper and nether millstone" of centuries ago, which ground the wheat of the Pharaohs, are substantially the same to-day. The old French quarry still turns out the best burrs known to the trade. These are usually from 30 inches to 54 inches in diameter. A 30-inch stone will cost $75, and $6 for every additional inch. This is for stone simply faced; if both faced and furrowed, add to the above 15 per cent. The average price of all the irons necessary to set the stone is about $100; curb and leader, $25, and $25 for setting the stones. The actual wear is but little. The depreciation of a good pair of burrs in twenty-five years would hardly reach 20 per cent. In a merchant mill they will need dressing about once a week, giving a day's work to the miller. Frequently after a fire the burrs will look scarcely injured, and yet a small amount of heat will render them entirely worthless. Their component parts are lime and marine shells. 'Tis said that the patent emery wheels for dressers went out of use on account of the heat generated damaging the surface of the stone. The spur wheels which drive the stones will need refilling about once in six to eight years, at a cost of from $100 to $150, depending upon the size of the wheel.

Bolting chests, as sent from the manufactory, comprise a paneled or cylinder chest, iron reel, cloth made up for it, and driving gearing. A sixteen foot chest and 40 inch reel, as above, including one 12-foot elevator, will cost $360, and a 20-foot chest, $540. Merchant mills have chests from two to four reels. The latter, with cloths, shafting, and gearing, will cost about $1,500. Iron bolting reels are worth from $40 to $50. The bolting cloth is made from the best quality of silk, and varies in price from $1.25 to $3.50 per yard, according to quality. To this 35 cents per yard is added for making up ready for the reel. A 40-inch reel requires one yard of cloth for each foot in length of the reel; the wear on the bolting chest is mainly confined to the cloth. This will depreciate in value from 25 per cent. to 33⅓ per cent. per year. When the mill is old the depreciation is more rapid, owing to bugs frequently destroying the meshes of the cloth. About 3 per cent. is the annual depreciation of the rest of the chest.

MIDDLINGS PURIFIERS.

These are of various patterns, some doing their work by means of a cloth and bolting chest, and others by a current of air. A machine sufficiently large for a burr mill will cost $275, and $100 additional for every extra burr. The average life of a purifier in a merchant mill is eight years, or a depreciation of 12½ per cent. A few millers insist that 5 per cent. is high enough.

SMUTTERS AND SEPARATORS.

"Where is the smutter located?" used to be a formidable question, and when found on the second or third floor, and the secretary of the company would return the application on that account, I early imbibed the idea that that particular machine was my special enemy in flouring mills, owing to its prominence in decreasing my commission account. 'Tis true, I could not see much sense in the company's rejection of the risk, and after watching the machine, and talking with the miller, I would be sometimes possessed with the heresy that the secretary never saw a smutter, and would not know one when he did see it.

All the satisfaction I could get was that the rapid motion —600 revolutions per minute—was apt to generate heat by friction. This I would quietly accept, and then solemnly ask the miller the next question: "Are the lower boxes kept constantly filled with tallow?" One irreverent Yankee wanted to know if the insurance company thought he kept them full of water, and I was further perplexed with the query whether the company thought he was such a consarned idiot as to try and save a few ounces of tallow and cut out the journals and boxes of a $200 smutter. Somehow or other the miller's argument struck me more forcibly than the attempted points of the secretary, and when he referred to a shaper in a neighboring furniture establishment which buzzed around at the rate of 6,000 revolutions a minute, and wanted to know if the application said anything about that, and whether it was required to be on the first floor or in the basement, I confess I left the mill with a very poor appreciation of the knowledge of the man who originated those flouring mill applications.

Dropping the experimental part of my subject and returning to figures, I find that a smutter, cleaning from ten to fifteen bushels of wheat per hour, is worth $110, and one

with a capacity of one hundred and twenty-five bushels, $250. In custom mills smutters have run twenty years and shown no material decrease in value. Merchant mills rarely use them longer than ten years. A smutter can be recased at a cost of from $15 to $20, making it almost as good as new.

ELEVATORS, CUPS, AND BELTS.

The cost of the belts varies according to length, width, and quality. The cups range from 3 in.×3 in.×3 in. to 10 in.×5½ in.×6 in.—the former pulley will cost 15 cents, and the latter fifty cents each. The iron elevator boot and pulley will cost $12. Fastening the cups to the belt, two cents each; and $1.50 per hundred for Norway iron bolts to fasten them on. The principal wear in elevators is confined to the cups.

A good belt in a merchant mill will last from ten to twelve years, whilst the cups will need replacing in from six months to two years. Taking all the elevators in a mill doing merchant work, 8 per cent. will cover the depreciation—and on an average custom mill 5 per cent.

A practical mill-furnishing man, and one who has often acted as appraiser for insurance companies, says that generally he estimates 5 per cent. depreciation annually for all the slow-geared machinery, and 10 per cent. for the fast. His impression, however, was that the estimate was rather strong, and millers in general seem to entertain similar ideas, and incline to materially reduce the per cent. named.

STAVE AND HEADING FACTORIES.

In some parts of the West these manufactories form no inconsiderable branch of industry. The companies ordinarily receive therefrom a good round rate, and, if taken in sufficient numbers, have a somewhat extended experience in examining their final papers. As these specials are often located where it is difficult to get appraisers on machinery, we give their cost somewhat in detail. The machinery here enumerated comprise all that is necessary to make staves and heading—and is the usual complement found in such hazards.

A stave cutter will cost new $200, setting up about $5. The wear is confined to rebabbitting the journals and replacing the knives. A full set of knives cost from $20 to $25, and will need replacing every year. The wear on the balance of the machine is trifling—not to exceed 5 per cent. per year.

A stave equalizer is a machine to cut all staves the same length—they cost set up $65. The principal wear is on the saws. These cost from $12 to $15, and will last about two years.

Heading and sawing machines are worth from $300 to $400. The saws will last about a year, and can be replaced at a cost of $45. The average wear is about 10 per cent. per year.

Cross-cut saws, for sawing bolts, cost set up $50. A year's work will ordinarily use up the saw, which will cost to replace about $20.

A heading planer is worth set up $350. This machine wears out faster than any other in the factory, and costs more to keep in repair. The boxes need rebabbitting every six months, and the knives replacing in less than a year. From two to three knives are used, and are worth $7 each. 12½ per cent. yearly is not a large depreciation.

Heading jointers vary in price from $75 to $200. About $125 is an average price. These have four knives, which will last a year and a half, and are worth $6 per set. If the knives are kept in good order, 5 per cent. a year will pay the wear on the balance of the machine.

Heading turners are worth $300. The principal wear here is in the knives and saws. These will rarely run more than a year, and are each worth $3. The worm which does the feeding will last from one to two years, and cost to replace about $2. The depreciation will not vary much from 10 per cent. a year. It must be borne in mind that the framework in all these machines is made of heavy iron, that there are no complicated, light parts to spring out of shape or break, and that generally, outside of the knives and saws, the wear is confined to the boxes and journals. The buildings containing this machinery are generally light, so that after a fire, unless the framework of the machines is broken or sprung, all the damage outside of knives and saws will not average over 25 to 30 per cent. of the cost of the balance of the machine. Our companies have paid for many total losses on stave machinery which afterward have been repaired for 50 per cent. of the money received.

These machines will stand considerable heating before the framework is injured in the least. A good adjuster can ordinarily settle such losses to better advantage than by calling in a machinist to estimate for him.

The belting, shafting, and pulleys for the machinery herein described will cost from $200 to $400, and will, on an average, depreciate 15 per cent. a year.

It is estimated that the cost of keeping the machinery of a stave factory in complete repair costs about 12½ per cent. annually.

The estimates herein given are all for soft wood or slack barrel factories. If hard wood is used the wear will be increased fully one-third.

IRON WORKERS.

I will not weary your patience by an attempted discussion of these important branches of industry, but pass them for some future time or leave them for abler minds to handle, simply remarking that the depreciation here is less than in wood workers. On an average the decrease in value of the entire machinery of a machine shop will not exceed 3 per cent. a year. Recently I examined a lathe which had done continuous work for twenty years, and the owner remarked that he would not exchange it for a new one. He did not consider the actual depreciation 10 per cent.

On all heavy machinery, such as shears, rolls, punches, trip-hammers, etc., the annual depreciation is very slight, hardly greater than a dwelling house. All these machines run slowly, and in addition must run accurately or they could not do the work, hence the wear by friction is reduced to the smallest possible limit. They are also made strong and invariably set on firm foundations to prevent springing and jarring. In addition, skilled labor is absolutely necessary to their successful working, so that many elements of depreciation entering into other machines are here unknown. The subject of iron workers is one which possesses, to me, more interest than any of the preceding classes, but in the limits of this paper I am reluctantly compelled to lay it down. The more we investigate this subject of machinery the more facts and ideas we find intimately connected with the questions of values, and closely related to the fire hazard. This imperfect connection of the practical relations of mechanical science to the profession of underwriting is but a mere outline of the undeveloped truths which will yet be brought to view. I confidently expect to see, during the next decade, a higher order of talent expended in this direction.

As an association we have only laid the foundation of a superstructure in which the elements of practical science are combined with the records of experience in all that pertains to a knowledge of values and computation of hazards.

The completed and finished temple is the work of the coming day. As the workmen of old labored, so should we work—that what we bring from the quarry of individual thought and experience to this *one* temple will be as perfect in all its parts as our best skill and judgment can make it. The future will demand not the rough ashlar, but the finished stone; not the crude offerings of the mere tyro, but the completed work of the master workman.

CONCLUSION.

In conclusion, allow me to remark that this paper is not what I intended it should be. Mechanical as is this subject there is a line of thought, scientific in its character and logical in its deductions, but which depends for its full development upon laws as yet undemonstrated. Divest a manufactory of a possible moral hazard, and simply apply the test physical, and there should be evolved a well defined law, producing mathematical ratios between the time a given machine has been run and its depreciation and between the number of risks carried and the periodicity of conflagrations. In looking for this law we search the books in vain, and the theories of mechanics fail to show us the light. The variableness of results, apparently arising from the same cause, disarranges our calculations and upsets our theories. A well defined law regulates the motion of the turning shaft, the revolving pulley, and the cog-geared pinion. From its very nature it can not stop here. It is unphilosophical to say that a part of mechanical and chemical forces are controlled by law, and a part the result of chance. One we know to be true because demonstration proves it. The other we do *not* know because as yet undiscovered. The one stands out as a realized fact, the other an undeveloped *possibility*. I ask a machinist why it is that two pulleys of the same material and size doing the same work do not wear alike, and he says he don't know. I see two engines identical in power and made from the same pattern, and one will do more work, wear much longer, and take less steam than the other. I want to know why this difference, but the logical answer is not heard. I look over the records of insurance losses, and I find of two companies writing on the same class of special hazards, one finds a profit and the other a loss. The percentage of loss of one may be 35, and the other 70, and I strive to know why this is so, and in striving end. That the ratio of depreciation arising from all the combined causes affecting the running of a machine, and a consequent decrease of value exists, I cannot for a moment doubt; but when I apply mathematical tests, whether to a wood worker running 6,000 revolutions, or an iron worker with 100 per minute, I find my results so variable in their character that one would almost think that there was mechanical attrition without definite results, and expending force without a controlling law. "Science finds identity amid diversity," says Lord Bacon. And yet nearly a century of American underwriting has passed by, and no scientist has as yet, from the diversity of result in the per cent. of depreciation and ratio of fire hazard, ever found sufficient identity upon which to form a rule of action.

We stand by a machine with its array of revolving wheels and pinions, and as it turns out the manufactured product, each after its own pattern, accurate and true, we seem to see in the cold iron and glistening steel a force almost human in its workings. We look into the anatomy of man, and we see the regular beatings of the heart-pump as it throws the life fluid throughout his organism; and in each we observe causes at work purely mechanical in their operations and but little different in results. To the one we apply laws and formulate tables of expectancy, and the life man has his chart. To the other, as firemen directly interested in results, we seek for no combined experience table, but trust the money of our stockholders to the seeming guidance of chance and luck. And yet the living embodiment of vital forces which in both creates the wear and in mechanics forms the elements of a possible combustion, should be governed by laws equally certain and true.

Into this mine of undeveloped science I had hoped to bring something available to our profession, but the line of thought could not be harnessed to the practical wagon of every-day life, and made to draw conclusions, circumscribed by financial laws: and so we leave it as we found it, unsystematized and undeveloped, and in its place give you these fragmentary thoughts, as a bare outline of that which will eventually be a demonstrated fact. The ideal in one's mind differs widely from the work as it falls from one's hand. The full, rounded possibilities of a mental creation too often lose their symmetry and beauty when we attempt to put them on paper or carry them into practical use. And yet in this grasping for the higher ranges of thought, searching into the hidden mysteries of nature's forces and striving for the seemingly unattainable, that, even in so prosaic a subject as mine, is not wholly without its reward. And so we lay our subject down with the cheering consciousness that although we have not reached the summit of our aspirations and produced upon paper the ideal transmuted into the practical, we have at least indicated a line of thought for more cultured and practical minds to develop.

HOW TO PREVENT THE RAPID SPREAD OF FIRE.

AT the recent session of the New York State Association of Underwriters, P. T. Wight, a consulting architect, gave the following in an interesting paper on "The Relations of Architecture to Underwriting":

It now only remains to describe the causes of the rapid spreading of fires through buildings, and the remedies to be applied in preventing them.

The main cause is the want of a proper system of compartments, whereby a fire can be confined to the place where it originates until it is extinguished. This is the prevalent fault in the planning of all business buildings, and this is the very class in which such precautions are most needed. Those features of modern buildings which are most fruitful in disasters are open elevator wells, light-holes, and stairways. The two former are most dangerous, because they are continuous vertical openings, while the latter may not be continuous, and may offer some obstruction to direct upward draughts.

It is often asked why the dangerous nature of elevators has become so much more evident lately than it was a few years ago. From some experience in connection with elevator protection, I will suggest this explanation: In stores and warehouses interior hoisting apparatus has been in use ever since the antiquated external cranes were abolished, perhaps for forty years, during which time most existing stores and warehouses in American cities have been erected, but until within about ten years past the hoistways consisted of square openings in the floors, through which a rope and hook were dropped from a windlass at the top, the windlass being worked by an endless rope passing over a wheel. These floor-openings commonly had trap-doors of wood, hinged on one side so that they could be opened and closed with facility. The modern elevator, which has been supplanting these inconvenient hoists, consists of a moveable platform, counterbalanced by weights, and operated either by hand, steam, or water power. The guides, safety appliances, counter-balances, and additional ropes required by this improved machinery, occupy so much space in the well-holes that the use of trap-doors has become extremely inconvenient, and in some cases impossible. Hence, where before the traps were closed at night there are now none to close, except in a few instances. When elevators are put in trap-doors disappear immediately, hence we constantly hear of increasing "elevator fires."

What is demanded by the present exigency is that not only should some provision be made for closing these dangerous openings but that human forgetfulness may not be depended upon, and that the power so skillfully used to propel elevators should also be applied to operate traps or valves automatically. The number of inventions having the accomplishment of this in view is almost legion. In the neighborhood of fifty patents for automatic hatchway-closers have been filed in the Patent Office already. Until recently but few have been put into practical use, and most of them have proved to be failures. A few were introduced in Boston after the fire of 1872. None have ever been used in New York with success. A few, applied to small elevators, have been recently tried in Philadelphia. Of a number introduced in St. Louis four years ago, where the local board allows a rebate for them, but one is now working. In Chicago one kind was attempted seven years ago, and failed. It is only within the last eighteen months that the problem has been successfully solved in that city, and now it has more elevators provided with automatic closers than all the other cities together. Two kinds are there used—one, the Meaker, the other the Van Asdel hatch-closer.

A large number of mill buildings in the New England States have been furnished with automatic closers, especially adapted to the simple styles of elevators there used, but not such as could be applied to the large steam and water elevators used in our modern warehouses. Besides the above, the Meaker automatic doors have been successfully applied to many brick shaft elevators in Chicago and Milwaukee. Brick shafts for elevators should always pass through the roof, and be sufficiently open at the top to allow smoke and flames to escape.

Light-holes and light-shafts are fully as dangerous in conducting fires as elevators. In business buildings inclosed light-shafts with openings in the sides should never be allowed, unless constructed like interior courts with brick walls and open at the top. If light-holes and skylights cannot be dispensed with, all such openings should be arranged to be covered at night on every floor, with movable shutters or blinds, sufficiently fireproof to resist the upward draught of a fire in its earlier stages. It is entirely practicable to provide these, and a mechanism may be used which will enable a person on the ground floor of any building to close all of such openings simultaneously by turning a wheel. Skylights over such openings should always be of heavy glass, in metal frames, and covered with strong wire-work to resist falling bodies. Stairways in stores and warehouses can only be made safe against the intrusion of fire by inclosing them with fire-proof partitions and placing a door, hung with spring butts, and covered with sheet iron or tin on the outside, at the foot of every flight. This is far preferable to letting down traps at night, because such traps would interfere with the free passage of firemen.

Care should be taken that no vertical air-boxes, chutes, inclosures, or elevator ropes or weights or other open constructions of wood are introduced in any building. The covered channels used to contain steam, water, or sewer pipes, are fruitful sources of danger to all buildings, and should be avoided by leaving such pipes exposed and closing the floors around them. Another danger to which all buildings containing machinery are exposed is found in the openings made in floors for belts or shafting. These should be reduced to the minimum. Systems of ventilation also which may be good in themselves, frequently conduce to the spreading of fires.

Unless due attention is given to closing all vertical openings such as those here indicated—and they by no means comprise all—the construction of fireproof ceilings and floors will be of little avail, and will not be worth the necessary expenditure.

But even if these precautions are observed, the absolute safety of the larger business structures can only be preserved by a proper system of subdivisions or compartments. The necessary size of such compartments will vary according to the use required of the building, but the smaller they are the better. The divisions may be made either with brick walls or the various styles of fireproof partitions that have been described. All openings in such partitions should be closed either with iron doors on both sides, or a heavy sliding wooden door, covered with tin or sheet iron on both sides. A recent invention provides for closing such sliding doors automatically. They run on inclined ways, so that the force of gravity will close them. The melting of a fusible link in a chain stretched across the top of the opening will release the doors, and allow them to close by their own weight.

PRINCIPLES OF HORSESHOEING.

1. To keep the foot healthy and sound, the hoof must not be mutilated by knife or rasp. The wall of the hoof is continually growing downward, and would grow to an indefinite length if it was not worn by the ground when the horse is in an unshod state. In the shod condition it grows at about the same rate, but the shoe prevents it being worn, and every time the horse has to be re-shod, the *superfluous* horn which has accumulated at the lower border of the wall since the last shoeing has to be removed by the rasp. This, I strenuously contend, is *all that is necessary* in the way of rasping and cutting. In reducing the wall to a proper length, and so preserving the *natural* angle and direction of the hoof, should consist the principal item of the farrier's skill. The reduction should be made from the lower or ground border of the wall, never from the front surface; and reduction should be so effected as not only to bring the hoof to a proper length, but to keep it also in proper relation to the direction of the limb, *i. e.*, the toe must not be too long, the heels too high nor too low, nor

one side of the foot higher than another. The latter condition makes the foot and limb appear crooked when looked at in front, and strains the ligament and cartilages on one side of the limb. As a general rule, the wall should be lowered to the level of the *unpared* sole.

The sole and frog should on no account be pared or touched by the knife, nor should the heels be "opened." The horny sole and frog, unlike the wall, do *not* grow indefinitely, but when they have attained a certain thickness they throw off the superfluous or old horn in flakes or scales. This natural thickness of the sole and frog horn is an absolutely essential condition for the maintenance of the foot in health and its protection from injury; and in proportion as it is diminished by the farrier's knife, so will the foot suffer. Not only does the solid horn play a most important part in protecting the sensitive parts it covers from injurious contact with the ground, or hard bodies such as stones, and keep the hoof strong and sound, but the semi-detached flakes it is always throwing off render great service, by acting as so many spring-shields when the horse puts his sole on stones or hard, unlevel ground, and also by retaining wet. They are, in fact, a kind of natural and ever present "stopping," which keeps the horn beneath moist and supple. Every flake on sole and frog, therefore, *is valuable*, and though these may appear as untidy to some eyes as the surface of the oak with its rough bark, yet to deprive them of this "dead" horn is almost as hurtful as denuding the tree of its covering. By leaving the sole and frog unpared, the farrier is spared some useless and pernicious labor.

2. The shoe worn by the horse should be as *light* as is compatible with a certain amount of wear, and adapted to the requirements of the work which the horse has to perform. I have already given reasons why no more weight should be added to the end of the limb than is absolutely necessary, in order to diminish the muscular fatigue, straining of tendons and ligaments, and reduce the number of nails required to secure the shoe to the hoof. The shoe, to be adapted to the various services sought from the horse, must be varied more or less in form and other particulars. But for fast-going, and especially weight-carrying horses, it should not prevent the frog resting on the ground, as it is these horses which most frequently suffer from navicular disease. And even with horses employed in slow draught, it would be well if their frogs could be allowed the same privilege, as they would then be much less liable to ossification of the lateral cartilages of the foot (sidebones).

Whatever pattern the shoe may assume, it *should not be beveled* on the foot surface so as to throw the weight on the margin of the foot, and leave a wide space between it and the sole. The upper or foot surface of the shoe ought to be a plane surface, resting alike on the wall and the border of the sole, as the latter is well adapted for weight-bearing; and the more the weight is distributed over the lower surface of the hoof, the better can the foot perform its functions and retain its soundness. This applies more particularly, of course, to the fore foot. Not only does this kind of shoe assist the foot better than the beveled shoe, but it prevents suction in heavy ground, and gives no lodgment to stones, etc., as well as yielding other advantages of a less noticeable kind.

But instead of having the lower or ground face of the shoe quite plane, as is usually the case, it should be beveled or concave. In fact, the best form of shoe is undoubtedly that which is just the reverse, so far as its surfaces are concerned, of that in everyday use. With the ground face of the shoe concave, a better foot-hold is secured, stones are less readily picked up, and in snow, "balling" is not so likely to occur.

Calkins for fast-moving horses should be dispensed with, if possible; or if they *must* be used, they should be low, and of the same height on both sides of the shoe. If worn by heavy draught-horses, they ought to be supplemented by a toe-piece at the front of the shoe, of the same height as the calkin. This not only keeps the foot level, but greatly assists the horse in draught.

3. The shoe should be fitted to the outline of the foot. If the wall has been reduced to its proper length, the shoe should follow the shape of the hoof, projecting slightly beyond it, if anything; so that no horn will be required to be rasped from the front of the hoof when the shoe has been nailed on. By adopting this precaution we preserve this part of the hoof in all its integrity, and likewise spare the farrier labor. In fitting the shoe, the coaptation between it and the hoof should be as close as possible. This can be most readily secured by applying the shoe at a high temperature, and for the briefest space of time, to the part upon which it is to rest. By this means the inequalities on the horn can be perceived and removed by the rasp, and when quite level, another brief application of the hot shoe fuses the horn into a hard, level surface, capable of resisting the pressure of the metal during wear.

This "hot-fitting" of the shoe, as it is termed, is perfectly harmless to the *unmutilated* hoof, and possesses such great advantages that it is to be commended. By "cold-fitting" it is impossible to obtain such coaptation; and, even it could be secured, the shoe would not remain so firmly attached, as wet softens the ends of the horn fibers in contact with the shoe, and they yield to the pressure, the shoe loses its original bed, becomes loose, and is cast. This is the experience of those who have tried this kind of fitting most extensively.

4. The number of nails employed to attach a shoe should be as few, and the nails as small, as is compatible with security. The reasons for this are obvious. Besides, the nails should not be driven any higher into the wall than is necessary to afford them a strong and solid hold. This is best obtained by a thick, low hold, instead of a thin, high one. In addition, a low hold injures the wall far less than a high one, as, at each shoeing, the old nail-holes are nearly or quite obliterated when the superfluous growth is removed, and the new nails have a sound horn to enter.

5. The face of the hoof should on no account be rasped or scraped, so as to remove or destroy the beautifully-smooth polished surface which an unshod hoof always exhibits, and which every hoof would show if the farrier did not attempt to make "fine work," and waste his time and tools. No oil or rubbish, designated hoof-ointments, should be applied to the horn. They are not only useless, but positively injurious. To the unrasped wall of the hoof, nothing is better than water applied by means of a sponge or soft-water brush when necessary.

THE CHARLIER METHOD MODIFIED.

These are the general principles which ought to be observed in the management of the horse's foot by the farrier. It will be seen that they reduce the art of shoeing to an exceedingly simple matter, and abridge the farrier's labor very considerably. They are founded on the knowledge that the hoof-horn is the *best* protection of the complex and beautiful structure it covers, and that these structures best maintain their health and integrity and perform their functions when the hoof is strong and sound, as in the unshod state. The chief object in shoeing the hoof is to prevent it being injured by *undue wear*. As to the prevention of "concussion" and the promotion of elasticity, *nothing can be devised which will answer the purpose so well as the unmutilated hoof.* When we have protected that part of the hoof which chiefly suffers from *wear* in the unshod state, nothing more is needed; and the less we interfere with it the better for the health of the foot and the welfare of the horse.

The kind of shoeing which is theoretically best calculated to maintain the foot in its pristine health and strength, is a modification of that known as the "Charlier" method, so named after the French gentleman who introduced it. This modification, which I believe I was the first, several years ago, to attempt, consists in embedding a very narrow rim of iron, about the thickness of the wall of the hoof, in a corresponding recess made in the margin of the latter. This rim does not extend so far as the heels, but stops a trifle beyond the quarters, taking the place of that part of the wall which would be broken or worn away if there was no shoe, and which is simply removed to make room for the more durable material.

The advantages of this system are various. In the first place, the under-surface of the foot meets the ground, as in the unshod state, and the functions of the several parts of the organ are not interfered with. Secondly, the weight of the rim of iron is less than one-half that of the ordinary shoe, and yet it generally wears longer. Thirdly, it requires fewer nails, and these of the very smallest size. Fourthly, such a rim *must* be made to fit exactly the circumference of the hoof.

For many years I have resorted to this method of shoeing the fore feet of horses (the shoeing of the hind feet is comparatively unimportant so far as disease is concerned), and with the very best results in the majority of cases. I say the majority, because, whether from previous long-continued bad shoeing, or from disease, one occasionally meets with feet that will not tolerate the short embedded shoe. Where, however, the wall is sufficiently sound, and the sole and frog healthy and unpared, there can be no doubt that this kind of shoeing is the simplest and best. And even for certain defective hoofs—as when the heels are contracted or the frogs diseased or wasted, I have found it the only remedy; and there are horses now in my regiment which cannot travel sound in any other shoe.

At each shoeing nothing more is necessary than to cut the recess a little higher up when the old rim is taken off, this deepening of it being equivalent to shortening or reducing the hoof in the usual process of shoeing. The sole should on no account be touched, even if it project *beyond* the level of the new rim; neither should any other part of the wall be interfered with, beyond that in which the recess is cut.

A few precautions must necessarily be observed by the farrier who will undertake to shoe horses in this fashion. The rim must be made of the very best iron, and it must be turned in such a way that its upper part is narrower than that which meets the ground, its outer edge *following the slope of the hoof*. The rim, toward the ends, must thin gradually away, *i. e.*, diminish in thickness, to correspond to the recess, which is cut deep in front, and gradually becomes shallower toward the quarters of the hoof. The upper inner edge of the rim must be well rounded in the first shoeings, if not always, to prevent accidents from the shoe driving back, and this edge, if it is left sharp, pressing too severely upon the inner angle of the recess. To further insure immunity from this accident, it is well to make a slight groove in this angle by means of a fine drawing-knife, so as to increase the interval between the edge of the shoe and sole at this part. And to prevent the shoe breaking at the nail holes—which, from its narrowness, it is liable to do—the holes should be made by a very fine-pointed round punch. In the course of hammering down the bulgings made by the punch on the sides of the rim, the holes become oval. The heads of the nails must be altered to the same shape, by rounding their corners with the hammer. The fine-pointed round punch does not cut the fiber of the iron like a thicker square punch; and this accounts for the extreme rarity of shoes breaking at the nail-holes, so far as my own experience has extended.

The recess requires a little practice to make quickly and neatly, so that it shall be regular and exactly the width of the shoe. Several years ago I devised a drawing-knife with a movable guide, which enables the farrier to cut the recess easily and perfectly exact. It is made by Arnold & Sons, 36 West Smithfield, London.

Some horses, when shod in this way, seem to experience some difficulty in understanding that they are shod at all; or the embedded rim gives them a peculiar sensation in their feet, as they do not move so freely, and, although their hoofs may be strong and sound, they travel somewhat "feelingly." This, however, *soon passes off*, and their ordinary action returns, and is generally much improved.

But it must be confessed that there is a great difficulty in inducing farriers to take any interest in this method of shoeing, or indeed in any but the stereotyped one to which they have been "to the manner born." And when, by dint of argument or persuasion, they can be prevailed upon to try this or any other novelty in their art, they either do it so half-heartedly, or exercise their abilities in such a perfunctory way, that failure and disappointment is certain to be the result. For this reason it is that the system of shoeing under consideration has made but little progress in public estimation; and until the owners of horses devote more attention to the welfare of their steeds, and emancipate themselves from the control and opinions of grooms and farriers, there is little hope that this or any other rational system of foot-management will become popular, or that the cruelty and loss inflicted by the ordinary irrational system of shoeing should be diminished to any appreciable extent.—*Dr. George Fleming, V. S., in the London Live Stock Journal Almanac.*

SHINGLE MANUFACTURE.

The manufacture of shingles is practically the same in all sections of the country, and comprises the two classes of breasted, usually spoken of as shaved, and sawed shingles.

Breasted or shaved shingles are in white pine, usually eighteen inches in length, the standard thickness being five shingles to two and one-half inches in thickness at the butt, and one-sixteenth inch at the point. Sometimes, though of late but seldom, they are made a full half inch thick at the butt. In some markets, notably as we go south, we find some white pine shingles 24 inches long, with butts five-eighths and points of one-eighth inch. The cypress and cedar shingles of Virginia and further South are largely of 20, 24, and 30 inches length by one-half inch butt.

A breasted shingle should be of full length with square ends, even thickness of butt and uniform points, with no clips at the point. The dressing or breasting should be perfectly smooth, as though planed, and free from ridges or grooves. Nothing less than a standard shingle of four inches wide should be packed in the bunch, although an occasional three inch is not criticised. The edges should be perfectly square, unless, as is practiced by some first class makers, the edges are uniformly beveled so that one edge will fit the next with a partial overlay.

Breasted shingles are usually packed in bunches of 500, or two bunches to the thousand, the bunches being packed 24 inches wide (six shingles) by 42 courses at each end. Cypress and other extra length shingles are packed in round bunches of 100 shingles each. Clipped and imperfectly breasted shingles are classed as No. 2, or common. Shaved shingles of less than seven-sixteenths butt must be uniform and nice to be admitted to the brand No. 1, or extra.

Sawed shingles are manufactured at different points, of different size. Michigan produces for the Eastern and Southern trade nothing but eighteen inch shingles, while the Chicago and Western trade demands only sixteen inch shingles. Some markets use fourteen inch and even twelve inch lengths.

The best sawed shingles are made from split quartered white pine, although the practice of quartering with a saw is an extended one. In the hands of an inexperienced sawyer a sawed block will often be made to turn out bastard shingles, which are objectionable, and, in fact, worthless upon a roof. Shingles should always be sawed with, and not across the grain. The inspection of shingles of all lengths is the same. Eighteen inch shingles are always sawed, three to two and a quarter inches at the butt, one-sixteenth points, except on special orders for cuts of five to two inches. Sixteen inch shingles are cut five to two inches at the butt, with one-sixteenth inch points.

There are so many designations given to shingles by various manufacturers, that it would be impolitic to give anything but standard classifications. Strictly first class shingles are always entitled to a brand of XXX, and in bunches so marked should be found only shingles of full length, full thicknesses, and uniform points, free from all rot, shake, sap, knots, worm holes, bastards, or defects of any nature; they should be packed in uniform bunches of 250 shingles, four inches wide always being the standard shingle. All shingles whose manufacturers have adopted fancy brands, such as "Star," "Extra," etc, should come up to the standard given for XXX.

No shingle should be packed in a bunch of No. 2 shingles, which is not free from all defects, sap included, to such extent that the shingle is perfect for at least six inches from the butt, and the defects from that to the point must be of a character which will forbid the passage of water through the shingles. These are by some makers branded "six inch clears," while a brand of "10 inch clear," or "12 inch clear," denotes a shingle free from defects for the length indicated, measuring from the butt. As a rule no shingle can be considered marketable which will not lay five inches to the weather in 18 inches, and four inches to the weather in 16 inches, without showing defects in the butt; 18 inch XXX are usually laid six inches to the weather, and 16 inch XXX are laid from four and a half to five inches to the weather.

It is not uncommon, however, to pack the coarse shingles in bunches marked No. 2, where the brands of XXX for the best, and X or XX for the clear butts is adopted. In connection with the brand "A," largely in vogue in the West, "choice A" are the equivalent of XXX, and are better than "standard A," only in some minor respect more fictitious than real, for anything which deserves the name of standard is supposed in shingles to mean the best, and custom of many years' standing has decreed that XXX shall always be a standard or choice shingle.

"Shaded A" may represent a clear butt of 6, 10, or 12 inches, but if the grade is below XXX, be it so called, or be it known as choice or standard, it is a No. 2, and its value can be fixed only by knowing to what extent the manufacturer looked upon defects as admissible in packing.

The main defects in shingles of any length may be summed up as follows: Bad sawing, the butts not running of even thickness, and the points being clipped or feathered. Bastard sawing, by which the grain of the timber runs across the shingle in circles instead of straight with the length. Bad jointing, so that one end is wider than the other, or by leaving sap, no matter how slight, or any other defect upon a XXX shingle or its equivalent by any name. Bad packing, leaving open spaces between the shingles; putting shingles that are defective in a bunch of XXX; allowing sap streaks, small knots, shake, rots, bad jointing, clips, or shingles sawed thicker or thinner than their mates, in a bunch alongside with them; packing shingles narrower than three inches, or a large number of that width in the bunch; mixing in hard, glassy timber, doty timber, worm-eaten or discolored shingles. No brand of shingles need hope to obtain a good reputation in any market where the sorting and packing has not been as carefully performed as it would be if the buyer stood by the packing frame and inspected each shingle separately. Manufacturers cannot too strongly impress upon their packers the fact that every shingle in a bunch must be, and is, by the brand, considered as warranted to be perfect in the grade in which it is packed, and nothing will so soon take a half dollar off the price of a lot of shingles as the finding of three or four defective pieces in a bunch. When a roof is shingled, there should not be found a single discarded shingle among the *débris*, and when a manufacturer brands his shingles with any of the marks denoting the highest grade, it is understood by the brand that every shingle is perfect.

A word to mill men on sawing. Never allow a wood butcher to handle a shingle saw; he will spoil more shingles and damage your reputation more than you can estimate. Discard your shingle saw and have it reground as soon as it wears down to 14 gauge, unless you prefer to cut your timber into sawdust rather than shingles. The thinner saw you can use the more profit in timber. It pays to get first class drag saw machinery and sawyers, as well as first class shingle sawyers. A poor hand is dear, if he even works for nothing and boards himself. A jointer can make a difference of one-third the day's cut by putting the timber in the shaving heap, or by using judgment and trimming only so much as is needed, but always doing that. If you have more than two packers, it will pay to keep an assorter to help and to watch them. The value of a reputation, in an increase of price and demand for your product, is worth the extra cost. Carelessness in this respect will entail more loss than paying 50 per cent. for money to carry on business with. A shingle shipper's reputation, like the virtue of Cæsar's wife,

should be above all suspicion, to insure a steady sale of his product, be the times good or bad.

Weights of shingles differ according to the character and specific gravity of the timber from which they are cut. In ordinary white pine a car load of 22,000 pounds of green shingles will be about as follows:

18 inch, green	52,000 to 55,000
18 inch, dry	60,000 to 65,000
16 inch, green	60,000 to 65,000
16 inch, dry	70,000 to 75,000

The above for an average. The writer has loaded 90,000 18-inch shaved shingles, five butts to two and one-quarter inches. Shingles one year old, seasoned under cover, on a ten ton rate.

ESTIMATING ROOFS AND WALLS.

If you wish to make an off-hand estimate of the number of shingles required for a roof at one-quarter pitch, multiply the ground surface of the house in square feet by 10. Example, a house, 20x20 on the ground, has 400 square feet, multiplied by 10, gives 4,000 shingles; if it is one-half pitch, add one-tenth more. For a close estimate it is better to obtain the square feet of roof surface (after allowing four inches on each side for lap of gables, and 10 inches on each eave, for lap over the moulding), then multiply by six, the product will give the number of shingles laid, five and one-half inches to the weather.

If 16-inch shingles are to be used, laid four and one-half inches to weather, divide the square feet by nine and multiply the product by 11.

To estimate lath, allow 14 pieces to the square yard. In estimating, allow 12 inches for baseboard, but include doors and windows. Shingles should lay 100 square feet, equal to 10 feet by 10 feet of roof surface.—*Northwestern Lumberman.*

BRACEWELL'S IMPROVED BLEACHING KIER.

We have had from time to time inquiries concerning this improved kier, and as it appears likely to prove of no small value to bleachers, calico printers, paper makers, etc., we proceed to give a short description of the apparatus, along with an illustration.

The peculiarity of the invention lies in the introduction

Fig. 1.

of the "fuse" or "puffer" pipe, of which a sectional view is shown in Fig. 2. This consists of a steam pipe, C, placed within a cast iron pipe, D, with trumpet shaped extremities. Its upper end is covered with a disk, J, called the indicator plate, and the lower end is closed with a dished cover. The lower portion of the fuse pipe, A A, is called the suction nozzle or well, and is so arranged within with steam passages and perforations that the liquor in the bottom of the kier is drawn into this well by the action of the

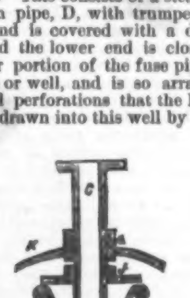


Fig. 2.

steam which passes down C, and is forced up to the top of D. An automatic pressure is kept up by the rising and falling of the indicator plate, J, at the top of D. The plate, J, is perforated, and slides freely upon C. Above it is fixed the spreader, K, which serves to distribute the liquor over the goods, which it protects from disturbance by breaking the shock of the liquid. Before the steam is turned on, the liquor is, of course, at the same level inside the fuse pipes and in the kier. On admitting the steam it is driven up the space, D, where it lifts the indicator plate, J, and falls down upon the goods in a thick spray. The indicator, J, falls, more liquor rushes into the fuse at B, to be again forced up and expelled as before, and thus, after steam is once turned on, a constant circulation is maintained without any personal attention, the indicator, J, rising and falling about every second, and by its noise showing that the machine is at work.

The advantages claimed for this invention are, that it is self-acting, that it requires only a very small quantity of steam, that the goods are always submerged and run no risk of being tendered, that the agitation of the cloth or yarn within the vessel is not to be feared, and that each kier may be worked separately. The total result obtained is a better and more uniform bleach at less cost. It must not be forgotten that the "fuse pipe," which is the essential part of the invention, and which is duly protected by letters patent, can be applied to any existing kier with little trouble or cost.—*Chemical Review.*

WOOD STAINS.

To turn oak black so as to cause it to resemble ebony, the wood should be immersed for forty-eight hours in a hot saturated solution of alum, and then brushed over several times with a logwood decoction, prepared as follows: Boil one part of best logwood with ten parts of water, filter through linen, and evaporate at a gentle heat until the volume is reduced one-half. To every quart of this add from ten to fifteen drops of a saturated solution of indigo, completely neutral. After applying this dye to the wood, rub the latter with a saturated and filtered solution of verdigris in hot concentrated acetic acid, and repeat the operation until a black of the desired density is obtained. To imitate rosewood a concentrated solution of hypermanganate of potassa is spread on the surface of the wood, and allowed to act until the desired shade is obtained. Five minutes suffice ordinarily to give a deep color. A few trials will indicate the proper proportions. The hypermanganate of potash is decomposed by the vegetable fibers, with the precipitation of brown peroxide of manganese, which the influence of the potash, at the same time set free, fixes in a durable manner on the fibers. When the action is terminated the wood is carefully washed with water, dried, and then oiled and polished in the usual manner. The effect produced by this process on several woods is remarkable. On the cherry, especially, it gives a beautiful red color.

ON GELATINO-BROMIDE OF SILVER.

By D. Van Monckhoven.*

I intend to give you a practical demonstration of the gelatino-bromide process, which will, ere long, according to my opinion, replace both the wet and dry collodion processes, owing to its extreme sensibility and to the easy manner in which it can be made.

I.—ORGANIZATION OF THE DARK ROOM.

The first thing that a person who intends to work this process must attend to is the best and proper light to be admitted into the developing room. For the wet collodion process it suffices to glaze the window with orange-yellow glass; but the film of silver bromide being sensitive to the yellow rays, the glass must be replaced by deep red-stained panes, for the red is the only color which does not act more or less upon silver bromide.

I have the honor to pass round for your inspection some specimens of the red glass which must be used. It is necessary to employ two pieces of this red-tinted glass superposed one above the other, and it would be well to put a sheet of white paper between the two.

As these panes transmit very little light the surface can be made larger, giving at least a square yard of illuminating surface. The window before which you manipulate ought to be of the height of an ordinary table, so that objects upon it may be easily distinguished.

It is necessary to hang a black curtain before the door of the dark room; for, as the gelatino-bromide plates possess such extreme rapidity, without this precaution you will obtain nothing but fogged proofs. Do not neglect the precaution of stopping up every crack or crevice in the dark room. Paint, if possible, the walls black. Shut yourself up in the dark room for a quarter of an hour, and stop up every crack or opening through which white light can enter. Put a prepared plate in the dark slide, open the shutter half way, and expose the plate thus half uncovered behind, near the red light of your dark room. Leave it a quarter of an hour and then develop it. If a dark line be visible it proves that your red glass is not sufficiently colored; therefore, you must put a third pane against the two others. Examine your dark slide, your cameras, and your lens.

Generally the dark slides let light in at the joints and hinges, and if the precaution to cover the apparatus be neglected fogged plates are the consequence. Landscape photography with gelatino-bromide plates is a real difficulty because of the imperfection of the ordinary photographic apparatus. You are now cautioned, therefore do not neglect the causes of failure which I have pointed out.

II.—NATURE OF THE EMULSION.

I begin now with the process itself. Here are two aqueous solutions—one of silver nitrate, the other of bromide of ammonium. If I pour the latter slowly into the former, so as always to have an excess of the silver salt, I obtain a curdy and heavy precipitate which unites easily by shaking at the bottom of the vessel. If I add an acid—say sulphuric acid—to the silver nitrate and pour the ammonium bromide into it, drop by drop, the precipitate is heavy and unites easily. But if I add ammonia instead of an acid I produce a light, white precipitate which remains in suspension in the water.

The experiment which I shall now make before you is strange but true. It is that if I employ a solution of gelatine instead of water the results are completely changed.

Here is a ten per cent. solution of gelatine. I add a few drops of ammonium bromide, and after having well shaken the liquid, I introduce a few drops of silver nitrate. You perceive that this solution remains perfectly transparent, although it contains silver bromide. I now pour it upon a piece of glass, and you see that it is perfectly transparent.

Now, if I allow this solution to remain until to-morrow this transparence will have disappeared. The silver bromide which exists at this moment in the liquid gelatine in a very finely divided molecular state will reunite in time and form thicker particles, and then the liquid will become milky. If I add a small quantity of sulphuric acid this will prevent the molecules from approaching, and the transparency will remain much longer; but, if I add ammonia instead, I immediately hasten the union of the particles of silver bromide. Now you see that the liquid has become milky, although I added only a few drops of the alkali. You see now that in gelatine solutions the reactions of alkaline bromides upon silver nitrate are, as regards the physical state of silver bromide produced, exactly the reverse of what is obtained in presence of water.

You all know, without doubt, how emulsions are prepared. A warm solution of gelatine is made, containing ammonium bromide, a solution of silver nitrate is added, and white silver bromide is thus formed in the solution. The more gelatine there is in proportion to the silver bromide the whiter and finer will the latter be found; the more diluted the solutions the finer the particles of silver bromide.

Practice teaches that this solution of gelatine containing silver bromide (which is now known under the name of "emulsion") must remain several days in a warm place, in order to obtain sensitive films. Why is this? and what occurs? The particles of silver bromide become larger and larger, and, at the same time, change from white to green.

Here are two plates covered with a gelatino-bromide emulsion. The first is quite white; it was prepared from the emulsion when newly made. The second is green; it was prepared with the same emulsion after having been cooked several days. In looking at the first through a magnifying glass it is difficult to distinguish the particles; but in the second you can discern them easily, especially upon the edges of the plate where the film is the thinner.

My friend, Dr. Vogel, of Berlin, affirms in his journal that the particles of silver bromide ought not to be seen by the microscope. Truly they are not seen, because in the film they are superposed one above the other, but render the film very thin and they are seen immediately even with a simple eyeglass. This experiment can not only be made with the plates I lay before you, but with those of Swan and all other commercial gelatino-bromide plates.

Experience teaches that the greener the gelatine pellicle is the more rapid is the impression in the camera. Here are two plates—one white and the other green, similar to those I showed you a few minutes ago. I took two similar ones, exposed them in the camera exactly the same number of seconds, and developed them side by side in the same tray. You can see that one is completely developed in all the half-tones, whereas the other shows only the high lights. The lengthy emulsification transforms the silver bromide, which is at first white and finely divided, into a green bromide very much coarser, but exceedingly sensitive to light.

III.—PREPARATION OF THE GELATINO-BROMIDE EMULSION.

I have already indicated my new and favorite method of preparing a gelatino-bromide emulsion. It consists in dissolving carbonate of silver in bromhydric acid, in the sirupy solution of gelatine. This method is extremely economical for those well acquainted with chemical manipulations; but it is extremely difficult for operators little versed in chemistry, and this is generally the case. I believe you will hear with great pleasure that I can indicate another method, very simple in execution, from which I can guarantee a certain and sure result, providing that you will follow to the letter my indications.

Procure some of Nelson's No. 1 photographic gelatine. I insist upon this point, because you will not succeed with German or French gelatines, which are prepared in a different manner from those of Nelson. Weigh up exactly ten grammes of this gelatine and eight grammes of pure and well-dried ammonium bromide. Put these two substances into a bottle and pour upon them 280 grammes of distilled water. In a quarter of an hour the gelatine will have swollen, and you can now put the bottle into a warm-water bath and agitate in order to dissolve the two substances.

Weigh up twelve grammes of silver nitrate and dissolve in fifty grammes of distilled water. Now pour the silver emulsion into the bottle containing the bromide, a little at a time, well shaking it after every addition. When all the silver solution has been added, pour in five centimeters of pure ammonia of a density of 0·910, and shake up well the solution. The ammonia exercises quite a special action here; its effect is to render the emulsion ready to be used in a few minutes, or, if great sensitiveness be required, it can be obtained in a few hours instead of days, and thus decomposition of the gelatine is avoided.

Now pour the solution of gelatine into a porcelain dish, and place it upon cold water and let it set. When set, detach it from the dish, place it in a strong linen sack, and wring it so that the gelatine is expelled in shreds, which are easily washed through a fine sieve. A washing of five hours in water three times changed suffices. Collect the pellicle on a clean linen cloth, and dissolve it at a temperature of 35° Centigrade, and it is fit for use. This process is a combination of those of Mr. Bennett and Messrs. Wratten and Wainwright, with this difference—that I add the ammonia in order to have the emulsion ready to work in a few hours instead of days.

I will pass over a few practical details, which you will find in a future edition of my "*Traité Général de Photographie.*" To explain them at present would lengthen enormously this lecture.

IV.—APPLICATION OF THE EMULSION TO GLASS.

Those who desire to prepare plates with emulsions made by themselves or bought from commercial houses must observe the following practical conditions: First of all, the window of the dark room must be of the height of the table on which the preparation is to be done in order that things may be easily seen and found. The table must be covered with a sheet of black marble perfectly leveled. In winter the plates to be prepared must be slightly warmed or the emulsion will not run well. In summer it is not necessary. The emulsion is heated to 40° Centigrade to render it liquid. It is now poured into a glass funnel, in the neck of which a tuft of cotton wool has been placed.* The funnel itself is placed in a double funnel made of metal and filled with warm water. The filtered solution is collected in a porcelain pot of the form of a cream-jug. In order to avoid bubbles the extremity of the funnel must touch the bottom of the jar. The filtration of the emulsion is absolutely indispensable in order to clear it from its mechanical impurities. The plate is placed horizontally upon three pieces of wood, the proper quantity of emulsion is poured upon the center

* A lecture delivered to the members of the Belgian Photographic Association.

* The cotton wool ought to be boiled about a quarter of an hour in caustic soda, one part water to 100 parts. Ordinary cotton will not filter the gelatine, because the fatty nature of the fibers repels the liquid.

(ten cubic cent. for 9x12) is now spread all over the plate by means of a glass spatula. The solution is leveled upon the plate by means of a *tour de main*, well known by all those who have practiced wet collodion.

The excess of emulsion must never be poured into the vessel containing the filtered emulsion, or the films will be filled with air bubbles. The plate covered with emulsion is now laid upon the marble table to set, during which time a second, third, and so forth are covered. The film of the first plate being set, it is put into a drying box, of which I will speak presently. It is necessary to continue the preparation of the plates until the whole of the emulsion has been employed. In summer, if the emulsion be long kept warm, or it has been allowed to cool and set in the bottle and then warmed up again, the gelatine loses its setting qualities, and "frilling" will be the consequence during development.

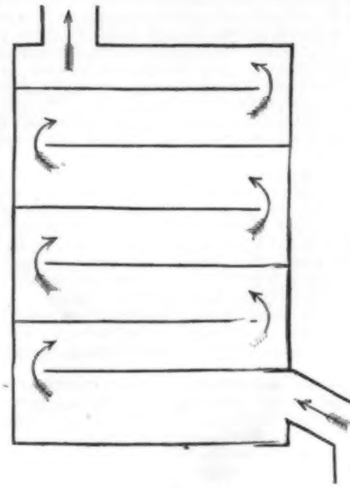


Fig. 1.

The drying box is easily made, and consists of a box of thick wood, on the top of which is a zinc pipe to connect it with a chimney. At the bottom is another pipe, but with an elbow to prevent light from entering. Horizontal shelves are placed in the interior, so that the current of air obtained by the draught in the chimney goes over each, one after the other. (See Fig. 1.) This box ought to be placed in a warm and very dark room. Without these precautions only fogged plates can be obtained. I again repeat, seeing the extreme sensitiveness of the gelatino-bromide of silver plates, all light not coming through the red glass must be excluded, without which non-success will be the consequence. Among the failures is the permanent production of fog in developing, especially if you employ very sensitive plates.

V.—PRESERVATION OF PREPARED PLATES.

The plates covered with gelatino-bromide emulsion cannot be left in the open air; they must be enveloped in a bag of black paper of the same form as a letter envelope. I generally put four in a bag, and interpose between the edges of the plates a piece of folded Bristol board. (See Fig. 2.)

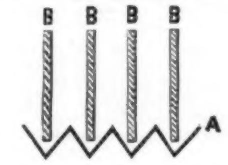


Fig. 2.—A, Bristol Board. B, Prepared Plates.

I inclose three of these bags in a cardboard box. The plates, if kept in a damp place, soon spoil and produce fogged images. Those kept in a dry place can be preserved several years.

VI.—EXPOSURE IN THE CAMERA.

This operation, so simple with the collodion process, becomes complicated because of the extreme sensibility of the gelatino-bromide preparation. I am certain that I shall not make a great mistake in saying that not one single dark slide of a camera protects the plate as it ought to do. Light enters especially through the shutter which rises to expose the plate. I have frequently proved this in the following manner: I have exposed a plate in the camera without taking the cap off the lens, and in developing the entire plate has been fogged. You must make certain that light does not enter through the holes of the Waterhouse diaphragms, nor round the ring upon which the lens is screwed. I am accustomed in the open air to completely envelop my camera with a large focusing cloth, allowing only the lens to protrude out of it. I even open the dark slide under the cloth. Without these precautions nine times out of ten fogged images are obtained.

VII.—DEVELOPMENT OF THE IMAGE.

The latent image can be developed immediately after exposure in the camera, or, if required, several days after. I believe, nevertheless, that if the development be postponed very long the impression will diffuse itself throughout the film and thus produce a fogged image.

Two methods of development are recommended—the first with a solution of alkaline pyrogallic acid, the other with oxalate of iron. The greater number of operators prefer the first, asserting that the exposure is shorter and the development more rapid than with the second. My personal experience is entirely opposed to this statement. I find that even with wet collodion the iron solution permits a shorter exposure than pyrogallic acid. I find also that images developed with pyro are duller and of a color which may deceive the photographer as to their intensity, and thus render the retouching very difficult. On the contrary, as you can judge by the number of negatives now before you, the color of the *clichés* developed by iron do not differ from the very best negatives made by the wet collodion process. I may even add that the pyro dirties the hands and must always be prepared fresh, whereas the iron can be used to develop a great number of negatives, and does not dirty the hands.

A short time ago I received a visit from three English amateurs. They had with them gelatino-bromide plates, prepared by the best commercial houses of England. We made a comparison, these gentlemen developing with pyro, and I with iron. I was able to diminish the exposure one-half, and they freely admitted my negative to be superior. I will now begin by informing you how to prepare the iron developer such as I use every day.

I employ two cans, similar to those used in our rustic kitchens to boil milk in; they contain each about a quart of liquid. In the first I put 200 grammes of purified iron sulphate, pour upon it half a liter of boiling water, and stir up the liquid with a glass spatula until all the iron is dissolved. I then throw in 100 grammes of oxalic acid, and keep on stirring until I feel no more crystals undissolved. A heavy precipitate of iron oxalate is formed in the hot liquid, which will settle at the bottom of the vessel in about ten minutes. I now decant off the clear liquid, and replace it by hot water and stir up. This I repeat four times in succession, leaving it to deposit each time about ten minutes.

During the time this operation is in hand I weigh up 250 grammes of neutral oxalate of potash (not ordinary but neutral), and put it into the second can. I add three-quarters of a liter of boiling water, and I stir up until all the salt is dissolved. I now pour this liquid upon the iron salt prepared as above (after having naturally decanted all the water off it) and stir up well. I now pour all the solution into a bottle of one liter (1,000 c.c.), and if the bottle be not quite full I fill up the difference with water. Do not leave the yellow powder in the can, all must be put in the bottle.

I now put into the bottle 100 grains of iron wire in pieces of fifteen centimeters in length. In this manner is made the iron developing solution, which can be used as soon as it has become perfectly cool.

To employ this solution I filter three-fourths of it into a vertical tray. "Why a vertical tray?" you may ask. Simply because in a horizontal tray the liquid offers such a large surface to the air, and so oxidizes very rapidly, the liquid thus losing its power of developing in a short time. In the vertical tray, on the contrary—above all, if it be kept closed when not used—the liquid remains good for several hours. Nevertheless the horizontal tray can be used, but as soon as a plate is developed it is necessary to pour the developer back into the bottle which contains the stock solution.

To restore the iron solution to its proper strength it suffices to return it to the bottle containing the iron wire and to shake up the whole. During the night, and even as soon as the daily work is done, the iron solution should be poured back into its stock bottle, which must always be kept full (by adding a saturated solution of neutral oxalate of potash). I advise, moreover, that the bottle be plunged into hot water so as to dissolve the deposit of oxalate crystallized at the bottom of the bottle, and which prevents the developer from retaining its virtues, or, in more exact terms, preventing its deoxidation by contact with the iron wire and the oxalate in the bottle. It is impossible to preserve the iron regenerator in a cold place, as the neutral oxalate will crystallize. I keep it always at a temperature of 15° Centigrade.

In order to understand this theory well you must know that the salt which develops the image is the ferrous oxalate, and that this salt is not very soluble in a cold solution of oxalate of potash; therefore it is indispensable to introduce new ferrous oxalate as soon as the solution becomes weakened. Our stock solution contains a great excess—sufficient, in fact, for the work of a whole week. But if we leave the potash salt to crystallize in the bottle it imprisons the ferrous oxalate, and we have no renewal of the strength of the solution. Hence the variations in the ferrous oxalate developer. It is very easy to obviate this inconvenience. First, to have several quarts of the iron solution in separate bottles; secondly, to put the bottle which has lost its qualities into hot water; thirdly, to prepare every other day a new developer. I hope you understand the importance of these observations. I promise you that if you give the proper attention the gelatino-bromide process will offer you less difficulty than the wet collodion process; that is to say, when you have practiced it a short time.

The formula for the iron developer just given is not complete. You must have a solution of 100 grammes of ammonium bromide in one liter of water, so that ten c.c. contain just one gramme of bromide. From ten to fifty c.c. of this solution must be added to each liter of the developer. This quantity is determined by experience, and we shall see shortly how to do it.

I said a short time ago that the developer was contained in a vertical tray. The plate to be developed is immersed directly in the solution. If the tray be horizontal the liquid is kept in motion; if the tray be vertical the plate is lifted up and down by means of the plate holder. If this precaution be neglected a great number of spots will be observed upon the surface, for the gelatine repulses the developer, and these kinds of fatty spots make so many stains in the image.

When the plate has remained about half a minute in the developer the high lights become visible. In about a minute or a minute and a half the details in the shades are to be seen; in two minutes, or three at the longest, the image is completely developed, which can be ascertained by looking at the back of the glass. The high lights have gone through the film. The plate is now washed and fixed. For this washing it is better to employ rain water.

The development proceeds in this manner only when all goes on well. It is probable that it will act in a different manner with you at the commencement, for we must all pay our tribute to gain experience. Very often at the beginning of the development the high lights come out well, but with the appearance of the half tints a change in the color of the plate comes on; it begins to fog, and, finally, the fog invades all, and the image disappears.

The cause of this fog may be attributed to too much light in the laboratory, by the red glass not being sufficiently stained, or from some white light entering the dark room through the cracks in the partition; or it may be that the dark slide is not light tight—in fact, one of these causes, or, perhaps, the whole of them combined.

If these causes of fog do not exist, still you have fog; but try the following: Take an unexposed plate and plunge it into the iron bath; if it fog, it is owing to your having prepared or dried your plate in a room in which the obscurity has not been complete. If, after all, however, this is not the true cause, add eleven, twenty, thirty, forty, or even fifty c.c. of your bromide solution to the liter of developer; shake well, and allow it to settle for a quarter of an hour. Plunge another unexposed plate into the developer and see if the plates still fog. If so it is in the drying of your plates or in the red glass you must seek for the cause of your non-success.

You will find the addition of the bromide to the oxalate of iron developer does not lengthen the time of exposure, but makes the development a more lengthy operation. What is gained is that the clear parts of the negative remain perfectly white by reflection, and after fixing the image will be perfectly clear and free from fog. With emulsions which will fog the only means to get over it is to give a double or even triple exposure in the camera, and to stop the development before the fog begins.

I informed you, when I first commenced, that the difference of sensitiveness in commercial plates was very considerable, but that it was very easy to ascertain their relative sensitiveness by a little practice. The greener and coarser the grain on the edges the more rapid they are. These last require greater care and special precautions in manipulations; more bromide in the developing solution can be employed with them.

When I began my experiments on gelatino-bromide plates I employed those of Mr. Swan, and could obtain nothing but fogged plates. I wrote to the maker, and he informed me that the cause of my non-success was owing to my red glass or the state of my dark slide. I then went to work and stopped up every crack in my dark room; reglazed my window with proper red glass; examined my dark slides, which in truth, were all in a bad state (although made by Dallmeyer). As soon as I took these precautions I had no more trouble with fog. You will pass through the same ordeal, and you will succeed like me in the end.

VIII.—PYRO DEVELOPMENT.

M. Obernetter, of Munich, who cultivates with great success the gelatino-bromide process, prefers the pyrogallic acid development to that of the oxalate of iron. Here is his system:

The following solutions are prepared beforehand:

1.	Water	10 parts.
	Potassium bromide	1 part.
2.	Alcohol	10 parts.
	Acid pyro	1 part.

These two solutions are kept in bottles having a dropping tube attached, containing ten c.c. Another dropping bottle is required, containing pure and concentrated ammonia.

To develop the plate is laid flat in a tray (it is not necessary to plunge the plate into water) containing the following solution:

Water	250 cubic centimeters.
Acid pyro	4 "
Bromide	2 "
Ammonia	10 drops.

This mixture must be made when about to be used and in the order given. In half a minute the high lights ought to come up; if they appear sooner five to ten c.c. of the bromide solution is added. If they do not show in half a minute five to ten drops of ammonia are employed—not put upon the image, but dropped into one of the corners of the tray where the greater quantity of the solution has been brought. Thus an under and over exposed plate can be corrected. The regenerator is allowed to act until sufficient density is obtained, which can be seen by lifting the plate out of the liquid and looking through it. It must be taken into consideration that the density will diminish during the fixing. The negative is now well washed and fixed.

IX.—FIXING THE IMAGE.

The image should be fixed in the dark room. Hyposulphite of soda is used for that purpose; strength 15°.* The fixing is slow, and so much slower in proportion as the film is greener and coarser in grain. Fixing with hypo is not so easy and simple as with wet collodion. The fixing solution colors easily, takes a dirty yellow tint from the oxalate of iron left in the film, and it communicates this tinge to the gelatine film; therefore a certain quantity must be prepared beforehand to replace the one employed for fixing as soon as the latter has been colored by the iron salt. You must not, in order to fix rapidly, employ a concentrated solution of hypo. Frilling and blisters in the film will be the consequence.

The film should be well washed after development, but even more so after the fixing. I wash, first of all, the plate under a tap for about thirty seconds, then I place it upright in a water bath for about a quarter of an hour, and finish up by a rinse under the tap for a few seconds. Without this precaution the image bleaches under the action of the intensifier, or, if it be not necessary to intensify, the film will leave the glass after having been varnished.

If the film blister or frill during development, or after or before fixing, the following excellent preventive, due to Mr. Mawdsley, must be tried: Before developing plunge the plate into a solution of ten grammes of chrome alum per liter of water; wash for a few seconds, and then put it into the developing solution.

X.—INTENSIFYING THE IMAGE.

Pyrogallic acid mixed with silver nitrate intensifies the gelatino-bromide negative; but it forms at the same time a red veil, because the silver combines with the gelatine. Mr. Swan has recommended as an intensifier potassium iodide dissolved in bichloride of mercury; but the negatives after a short time turn of a chrome yellow color. I have succeeded in discovering that an alkaline solution of silver could be employed instead of an acid solution, as is generally used; but indirect means must be employed to gain this end.

I will now operate under your eyes, as I have already done for the other experiments. This bottle contains—

Distilled water	1 liter.
Bichloride of mercury	20 grammes.
Bromide of potassium	20 "

This other bottle holds—

Distilled water	1 liter.
Nitrate of silver	20 grammes.
Cyanide of potassium, pure and crystallized	20 "

In order to make the first solution put the bichloride of mercury into a mortar, and grind up with the water until all is dissolved, and then add the bromide of potassium. To prepare the second solution dissolve the nitrate of silver in half a liter of water, then the cyanide in the other half liter, and mix the two solutions. A slight precipitate of cyanide of silver will be seen at the bottom of the bottle, and must remain. I wish to insist upon the necessity of employing pure and crystallized cyanide of potassium; ordinary cyanide will not answer the purpose.

* Cyanide of potassium attacks the image without pure and crystallized cyanide be used, and that at two per cent. strength.

The negative can be intensified either immediately after the washing which followed the fixing, or it can be employed upon a negative which has been dried. In the latter case the negative must be steeped for a minute or two in a water bath.

Plunge the negative into the bichloride of mercury solution,* and leave it a longer or a shorter space of time according to the intensity required. The extreme limit is attained when the image has become white. Wash well under the tap. Now immerse the negative in the second solution. It must remain only a few seconds if its stay was but short in the bichloride of mercury. If it had been a long time in that solution it can remain also pretty long in the cyanide solution without danger. At all events, it is necessary that the white produced on the negative by the mercury bath disappear in the second solution. This can be seen by examining the negative from the back. The negative must not remain too long in the cyanide of silver bath, because the latter reacts on the blacks of the image and takes away a part of their intensity.

The negative is now thoroughly washed and dried without going into the hypo solution again, as the solution would destroy all the intensity obtained. The successive action of the cyanide of silver and the bichloride of mercury has for its object to produce a violet chloride of mercury in the blacks of the image. This salt does not change by the action of light. The result of this intensifier is superb; one would think that the negatives were produced by wet collodion. Everyday practice confirms the value of this process. Time alone will show its usefulness.

XI.—RETOUCHING AND VARNISHING.

Some photographers retouch their negatives before varnishing, because the matt surface of the gelatino-bromide plates offers every convenience to retouch either with the lead pencil or with the *estoupe* (drawing stump). Others retouch after the application of the varnish. As to varnishing, the operation is the same as for collodion, only great care must be paid to drive out from the gelatine film all moisture by applying a gentle heat to the negative before you attempt to varnish.

The gelatino-bromide process is the process of the future. Twenty times more rapidity can be obtained than by the wet collodion, and the plates can be prepared beforehand. These two advantages alone are immense. So great are they that I am certain wet collodion has seen its best days. For this reason I did not hesitate one instant to make gelatino-bromide the object of my exclusive studies. I shall indeed be happy if the few indications that I have given will be of service to you.

* If the negative be covered with a white veil it proves that the hypo has not been properly eliminated.

HELIOTYPIC PRINTING PLATES.

Take of glue (Koelner leim) 1 kilogramme, allow it to swell for 24 hours in some cold water, and then liquefy the pieces at a temperature of 25° R., adding 20 grammes of potassium bichromate. Pour this solution over a suitable square of plate glass, previously coated with ox gall and provided with a rim of putty, and allow to dry in a dark place. After the lapse of two days the glue tablet can be readily detached. Now place on the smooth surface the transparent negative drawn in bold lines and strong contrast of lights and shades, or made of perforated cardboard, and, expose to the sunlight for from one to three hours. After the exposure glue the tablet with its back side to a smooth wood block, moisten the face with water, and finally remove by means of a soft moist cloth all glue not hardened under the influence of light, when the *cliche* will show the drawing in perfect relief with a smooth printing surface. After completely hardening the *cliche* in the light, it is ready to be used in the printing press. Galvano-plastic copies of this plate may also be taken in the usual manner.—*Indust. Bl.*

A NEW QUANTITATIVE ANALYTICAL METHOD OF EXTENSIVE APPLICABILITY.

Prof. A. Classen has extended his method of separating zinc from manganese, ferric oxide, and alumina from manganese, and of determining cobalt and nickel, so that it is now applicable, not merely to the estimation of single constituents of complex bodies, but of all the ingredients present. The following summary of his process is taken from the *Zeitschrift für Analytische Chemie:*

The determination of magnesium and its separation from the alkalies is effected by adding to the aqueous solution, whose volume should be about 25 c.c., a hot saturated solution of ammonium oxalate, or by dissolving in it solid ammonium oxalate with the aid of heat; boiling, adding an equal volume of acetic acid at 80 per cent., maintaining the mixture at a boil for some minutes with constant stirring, allowing to stand for six hours at 50°, filtering, and washing the precipitate with a mixture of equal volumes acetic acid, alcohol, and water. The precipitate and filter, still moist, are heated to dryness in a covered crucible, at first very gently, and then with access of air, but with a small flame till the carbon is consumed, and finally strongly ignited, when the magnesium is weighed. The latter is dense and heavy, and no loss is to be apprehended on ignition. In order to separate magnesium from the alkalies the oxalate must be precipitated from more dilute solutions, otherwise a double oxalate of magnesium and potassium is formed and is not decomposed by the subsequent treatment, whence the magnesium is contaminated with potassium carbonate. The liquid, about 50 c.c., is therefore mixed with a cold saturated solution of ammonium oxalate (1:24), and ⅙ vol. of alcohol is added. The magnesia thus prepared contains no potassium, or mere spectroscopic traces, and the precipitation of the magnesium is complete. The process is applicable whether the alkalies are present, as chlorides, sulphates, or nitrates.

For the complete precipitation of manganese oxalate, Classen adds zinc chloride; in cases where the presence of zinc would be inconvenient he uses magnesium chloride, in such quantity that for each mol. of manganic oxide at least 1 mol. magnesia must be present, otherwise the residue, after ignition, is a mixture of manganic and manganoso-manganic oxides. For determining the zinc oxide the solutions are freed from all uncombined acid by evaporation in the water bath, and, in case of sulphuric acid, by subsequent heating in the sand bath; the residue is moistened with a few drops of dilute nitric acid, or digested for a short time with about 10 c.c. bromine water. A sufficient quantity of neutral potassium oxalate (1:3), about seven times the weight of the oxide, is added, the mixture is heated in the water bath, and the ferric oxide is dissolved by the addition of acetic acid in drops. The whole is then heated to a boil, an equal volume at least of acetic acid is added, and, after standing for six hours, it is filtered while still warm, washed with the mixture of acetic acid and alcohol, and the zinc oxalate is ignited. Nickel and cobalt are determined in a similar manner; the washed oxalates are ignited, washed again, and reignited. The oxalate of nickel is precipitated in a crystalline state only when in small quantity, wherefore it is prudent to take only small quantities of the substance for analysis. Cobalt oxide is reduced in a current of hydrogen and weighed as metal.

Copper oxalate, if precipitated in the manner described for zinc and manganese, falls in a state of very fine division and settles badly. The determination is accurate and convenient if a sufficient quantity of potassium oxalate is added to the neutral concentrated solution. After a time the greater part of the copper separates in fine blue acicular crystals, as cupro-potassic oxalate, and, on adding an equal volume of acetic acid and allowing the liquid to stand, the residue of the copper is completely precipitated. The precipitate, after washing, is gently ignited, lixiviated, and reignited till the weight becomes constant, or, as Classen prefers, dissolved in dilute sulphuric acid, and the copper determined electrolytically by means of a thermo-battery or two Bunsen elements. In presence of antimony and arsenic chloride along with iron, as in the analysis of fahl-ores, the copper is not completely separated by the process above described, not even on the addition of zinc or magnesium chlorides. If but little antimony is present the substance is dissolved in nitric acid, the solution evaporated to dryness, the residue mixed with potassium oxalate in excess, filtered while hot, washed with a little water containing potassium oxalate, and the filtrate concentrated to 50 c.c. In presence of larger proportions of antimony the substance, finely pulverized and mixed with 4 four parts ammonium chloride, is very gently ignited in a covered crucible, and thus almost all the arsenic and antimony, together with the greater part of the iron, are driven off as chlorides. The copper is then determined as above.

The separation of phosphoric acid from such oxides as form with potassium oxalate soluble double salts, capable of being decomposed by acetic acid, *e.g.*, lime, is effected by the separation of the oxalate, as described above. Ferric oxide and alumina, whose oxalates form with potassium oxalate double salts not decomposable by acetic acid, are completely eliminated by means of alcohol. The phosphate is dissolved in hydrochloric acid, evaporated to dryness, mixed with potassium oxalate six times the weight of the oxides, and digested for a short time in the water bath, the ferric oxide dissolved by acetic acid, and the same acid in excess and alcohol at 95 per cent. are added as long as a precipitate is formed. After standing for six hours the precipitate is filtered, washed with alcohol, the filtrate in the beaker concentrated on the sand bath to expel acetic acid and alcohol, the residue, almost dry, is diluted with water, any silica which separates is filtered off, and the phosphoric acid precipitated by means of ammonia and magnesia mixture. The process is suitable for the determination of phosphorus in crude iron. Arsenic acid behaves like phosphoric acid. Salts of cobalt, nickel, and zinc do not retain arsenic.—*Chemical News.*

TURKEY-RED OIL.

By G. Stein.

The author's method is to weigh 10 grammes of the sample into a porcelain capsule holding about 125 c.c., adding 75 c.c. cold saturated solution of common salt and 25 grammes of dry wax. The whole is then heated on a water bath. As turkey-red oil is insoluble in brine, it rises in an anhydrous condition to the surface and combines with the melted wax. The cake of wax, when cold, is freed from brine by means of filter paper, dried over sulphuric acid and weighed. On deducting the known weight of the wax the residue is the real oil.

DETERMINING SULPHUR.

By Albert Colson.

The author proposes to burn pyrites in a current of oxygen, and to titrate the products of combustion. The operation is carried on in a tube of green glass, placed in a furnace for organic analysis. One end of the tube is sealed, and to the other is fitted a stopper with two holes. One of these serves for the escape of the gaseous products of combustion which are received in a Liebig's bulb apparatus containing standard caustic soda. Through the other hole passes a long, narrow tube, which conveys oxygen, free from water and carbonic acid, to a small platinum boat placed near the closed end of the combustion tube, and containing half a gramme of the pyrites, spread out in a thin layer. A plug of asbestos is placed about the middle of the tube to avoid projections. Heat is first applied toward the open end of the tube, and as it approaches redness it is gradually extended toward the closed end. The current of oxygen is regulated so as to be always in excess. The disappearance of the white vapors formed in the bulb tube during the operation is a sign that the sulphurous acid is expelled from the combustion tube. The open end of the tube and the stopper are then washed, and the washings are added to the liquid in the bulb tube, the sulphurous acid in which is then determined in the usual manner. If the pyrites contain carbonates, standard solutions cannot be used. It is then necessary to oxidize the sulphurous acid and determine the sulphuric acid formed.

COMPOUND NATURE OF PHOSPHORUS.

Letter from Mr. N. Lockyer to M. Dumas.

Phosphorus heated in a tube with copper gives a very brilliant hydrogen spectrum. Phosphorus alone heated in a tube where a vacuum has been formed by Sprengel's apparatus, gives nothing. Phosphorus, at the negative pole in a similar tube, gives very abundantly a gas which shows the spectrum of hydrogen, but which is not hydrogen phosphide.

SPONGY SILVER.

Prepare silver tartrate by double decomposition of silver nitrate and potassium and sodium tartrate, washing the white precipitate, and drying under exclusion of light. When this impalpable powder, perfectly dry, is heated on a thin sheet of copper or brass, over a Bunsen burner or an ordinary spirit flame, it will be seen to puff up into a voluminous shining mass of pure spongy silver.—*Boettger.*

FAST SCARLET WITHOUT COCHINEAL.

For 66 lb. woolen yarn add to a boiling water 1 lb. 1½ oz. of starch and 8⅓ ounce measure of tin solution. Skim carefully, add 22¾ oz. crystallized tartar, enter the wetted yarns, and turn for 15 minutes. Add the clear solution of 15¾ oz. "naphthaline ponceau R" (Meister, Lucius, and Brüning, of Hochot), in two portions, turn for 15 minutes without boiling, add 16½ ounce measure of the tin solution, and boil gently for half an hour. The tin solution is prepared by dissolving 560 parts of pure tin (granulated) in a mixture of 2,000 parts muriatic acid, 667 aqua fortis, and 667 parts water, the parts by weight.—*Deutsche Färber Zeitung.*

CURIOUS CASE OF LOSS OF PERSONAL IDENTITY.

Dr. A. H. Hewetek, of St. Clairsville, Ohio, writes as follows to the New York *Hospital Gazette:* I have had under my care as physician for our county infirmary a very interesting case. There is no discoverable bodily disease, but a very peculiar mental state. The patient has lost all knowledge of his personal identity; does not know who he is, where he came from, or whither he was going. He became an inmate of our infirmary about nine months since. The following in his history since taken in charge by our county officials. All previous to that is a blank to himself and entirely unknown to us:

About the time referred to, nine months since, he found himself standing upon the depot in Bellaire city with a little money in his pocket and a small traveling bag in his hand. This bag contained a change of linen, pair of scissors, and some blank paper like that used by editors. His clothes were quite genteel, and the underwear in his valise was neat and clean. His entire appearance was that of a well-cared-for gentleman ready for business.

There was no name on any property about him indicating who he was: entirely nameless, except on some part of his effects was the name Ralph. This is what he is called in the infirmary.

After thinking and thinking while at the depot he at last went to the nearest hotel and gave the landlord a candid statement of his very strange condition. He asked for a bed, said he had a little money, that he would be no trouble, and that he felt sure this strange mental sickness would soon pass off. The landlord became interested in his case.

The same day a gentleman came to Bellaire to lecture on temperance. Stopping at the same hotel, he soon made the acquaintance of Ralph and invited him to attend the lecture. While attentively listening some impulse came over him which he could not resist, and he found himself out in the street smashing the saloon windows with a big club. The roughs ran out, beat and abused him badly, breaking the neck of the humerus and beating one side all black and blue. This brought him into the hands of the police. But the lecturer, the doctor, the landlord, and mayor all became interested in finding out who he was. They made every effort, but utterly failed.

He certainly is a man of more than the average ability; has had quite an extensive knowledge of business, and is very expert with the pen. Some think that he must have been connected with the press; others, a clerk in some calling in which the use of the pen and figuring was the daily habit. In this way alone can they explain his great expertness.

His knowledge is entirely correct upon all matters disconnected with the question of identity. He has the use of his mental powers in all other directions.

I made him, after having the best evidence of his fitness, my assistant. He has put up all the medicine, etc. I procured him Parrish's Pharmacy, and in a remarkably short time he was able to fill any prescription I required, and in many other ways to assist me.

So great is his general knowledge, and so correct all his recollections of general events, and all special duties imposed upon him, that many were skeptical and believed him to be feigning. But, after nine months close observation, we are all forced to believe that he is what he says he is—a man with no knowledge of his personal identity.

He is about fifty years of age; rather spare; has dark hair, well sprinkled with gray, and is quite a gentleman in appearance. He has made himself so useful, agreeable, and so anxious to return all he can for the benefits he has received, that he was presented with a new suit of clothes and directed to eat at the superintendent's table.

I report the case both on account of its psychological interest, and that possibly it may lead to his identity.

He has been published in our newspapers pretty thoroughly, but these have a much more limited circulation than a medical journal like yours.

THE EUCALYPTUS AND THE PINE CONSIDERED IN RELATION TO THEIR SANITARY PROPERTIES.*

By C. T. Kingzett, F.C.S., F.I.C.

As is widely known, both the eucalyptus and the pine have long enjoyed a popular reputation as health agents. In particular the eucalyptus has acquired the character of the "fever-destroying tree," and has been largely cultivated in various parts of the world with the view of rendering habitable large districts previously devastated and depopulated by malaria, etc. In this paper the author, referring to the old theory of the action of the eucalyptus, which attributes its sanitary powers to its drainage properties, shows that this hypothesis always lacked evidence, and at its best was of a negative character. In the first place, the eucalyptus is only superior to other trees as a means of drainage in the proportion in which its rate of growth exceeds that of other trees, and this is not sufficiently notable to account for its extraordinary fever-destroying properties. Then, again, other trees, even if planted in malarial districts, do not free them from the disease, so that the *action* of the eucalyptus is of a positive type, and like the pine tree, its properties are of a healthful nature, upon whatever soil or in whatever climate it may grow, whether in deep valleys or upon the sides of mountains. Others have maintained that just as pine forests are supposed to exert their beneficial influence upon persons suffering from pulmonary and other affections, by virtue of the volatile emanations arising from them, so the eucalyptus produces its well-known effects by the oil which is evaporated from its leaves. Mr. Kingzett then examines this hypothesis in detail, and shows the relative oil-yielding power of the different species of eucalyptus. The genus embraces over 130 species, and of these *Eucalyptus amygdalina* is the most abundant oil-giving tree, 100 lb. of the leaves giving from 3 to 6 lb. of the oil.

* Abstract of a paper read before the Health Section of the Social Science Congress, Manchester.

This oil is practically identical in composition with the oil of turpentine derived from pine trees, and with most of the so-called essential oils or perfumes. By the investigations of Mr. Kingzett, it has been ascertained that all these oils, when subjected to the action of atmospheric oxygen and moisture, produce peroxide of hydrogen and a number of camphoraceous substances having marked antiseptic powers. Knowing, then, how much of these substances are yielded in the laboratory by a given quantity of oil of eucalyptus or oil of turpentine, Mr. Kingzett has extended his calculations to the pine and eucalyptus forests, which are so abundantly distributed in nature. Taking New South Wales and South Australia alone, he calculates that the eucalyptus forests of this district contain at any given moment sufficient oil in the leaves (ready to be evaporated into the atmosphere under the agency of warm winds) to form by contact with the atmosphere no less than 92,785,023 tons of pure peroxide of hydrogen and 507,587,945 tons of camphoraceous principles. Now if it be remembered that in nature all matters of animal and vegetable origin are oxidized by the atmosphere, which is thus kept free from the pernicious products of putrefaction, and that peroxide of hydrogen is a much more powerful oxidant than ordinary oxygen, and if it be also borne in mind that the camphoraceous products above referred to are also powerful antiseptic agents, then the healthful influences of the eucalyptus can neither be wondered at nor be longer open to any doubt. What is true of the eucalyptus is true also of the pine, and on an immensely larger scale, for pine forests are distributed freely over both hemispheres, and the oil of turpentine, which is a natural product of these trees, undergoes the same chemical changes in the atmosphere as oil of eucalyptus. By imitating this natural process of oil oxidation, Mr. Kingzett has, as is well known, succeeded in obtaining and rendering available in commerce the antiseptic and oxidizing principles to which pine and eucalyptus forests owe their hygienic influences.

NEURALGIA CURED BY NERVE-STRETCHING.

DR. KOCHER relates, in the *Correspondenzblatt für Schweizer Aerzte*, November 11, 1879, the case of a man aged 32, who had for seventeen years suffered from neuralgia of the right supraorbital nerve. The attacks, at first rare, afterward became more frequent, until at last there were only brief intervals of freedom from pain. All the ordinary therapeutic measures had been tried for years without success. Dr. Kocher laid bare the nerve and three of its branches by an incision along the upper border of the orbit, and stretched it forcibly by means of an aneurism needle passed under it. The healing of the wound was attended with abundant suppuration. From the moment of the operation the patient was free from pain, and the neighborhood of the supraorbital nerve was anæsthetic. The patient was last seen three months after the operation; he had had no return of the pain; sensation was diminished over a space ten *centimeters* in extent, but was otherwise perfectly restored. After neurectomy, paroxysms of pain are usually observed during the first few days after the operation. As these were absent in the present case, Dr. Kocher concludes that the lesion of the nerve is less when the nerve is stretched than when it is divided. The value of nerve-stretching as a substitute for excision will be greater in neuralgia of the second and third divisions of the fifth nerve, as here a much smaller wound will suffice.—*Brit. Med. Jour.*

ANTI-FAT.

DR. CARSON, Portrush, Ireland, writes to the *British Medical Journal*: "'Anti-fat,' now much advertised as a remedy for obesity, is stated to be an extract from the *Fucus vesiculosus*. Some who are paying expensively for the remedy may be surprised to hear that the *Fucus vesiculosus* is here largely used as a food for pigs, and that it in no way interferes with their growth. It will require a number of well reported cases to convince me that what fattens a pig will make a Christian lean. I have myself visited a sty to verify the fact that it was really the *Fucus vesiculosus* which the pigs were getting.

CARRE'S DI-ELECTRIC MACHINE.

A CORRESPONDENT of the *English Mechanic* states that he had occasion to compare the various kinds of induction and friction machines at the Exhibition of Scientific Apparatus in the Palais de l'Industrie, at Paris, and to experiment practically with the newest and most perfect form of Carré's di-electric machine, which he considers the most efficient of its kind, and about which he gives the following information:

This apparatus in reality consists of two machines, the one being an ordinary friction machine, such as Winter's well known instrument, the other a di-electric induction apparatus similar to the famous Holtz machine. Our illustration, Fig. 1, represents the compound machine. A is a disk of glass, which can be made to revolve on its axis by means of the pulley and handle, M. A pair of rubbers, D, consisting of silk or leather covered cushions, are fixed so as to press right and left against the revolving disk. This apparatus, fixed on the wooden base shown in the illustration, constitutes the friction machine or first part of the instrument. A second disk, B, of glass or ebonite, and much larger in diameter, the "di-electric," is fixed higher on a second spindle. By means of a small pulley and cord it is made to revolve 10 times for every revolution of the smaller disk. A large metal conductor, C, is mounted over the disk on insulating pillars made of glass. Fastened to this large conductor is a metal rod, F, with a series of projecting points directed against the top of the revolving di-electric disk, but not actually touching the latter. A rectangular piece of vulcanite, shown better in Fig. 2, is attached to the same, but placed opposite the points on the other side of the disk. The metal rod, E, with points similar to the one described above, is fixed against the lower part of the disk, and a movable rod, F, is in connection with E. The conductor, F, can be joined to "earth" by means of a brass chain.

In order to be able to give a clear explanation of the working of this most interesting machine, I must put down first those elementary scientific principles or laws upon which its action is based, and to which we shall have to refer.

After that I shall describe, separately, first, the friction engine, and secondly, the induction apparatus.

1. Any substance which is not electrically excited is said to be of a neutral condition, and supposed to be charged with positive and negative electricity in the same degree, the two charges neutralizing or destroying each other.

2. A body can be charged with positive electricity by having its negative charge abstracted, or *vice versa*.

3. If a dry rod or plate of glass is rubbed with silk or leather, the glass becomes charged with positive electricity, the rubber acquiring at the same time a negative charge.

4. If the rubber employed in the process is covered with powdered amalgam, the result obtained is much better.

5. A plate of insulating material, say glass or ebonite, placed between two bodies, of which one or both may be charged with electricity, is called a di-electric.

6. Electric induction by invisible agency takes place through the di-electric.

7. If a body charged with positive electricity (A, Fig. 2) is placed near a di-electric, B, and a metal conductor, E, on the other side of the di-electric, the conductor, E, deposits negative electricity on the di-electric, and (according to principle 2 above) becomes charged with positive electricity.

1. THE FRICTION MACHINE.

In the ordinary plate machine, as represented in the lower portion of our illustration, Fig. 1, a disk of glass, A, is made to revolve. Pressed against its sides are two cushions, D, to which a silk cover may be attached. The action of the apparatus is greatly improved if the cushions are covered with powdered amalgam, which is put on by means of tallow. The friction caused by the pressure of the rubbers against the plates excites the electric charge; in other words, it separates the two kinds of electricity, leaving a positive charge on the glass and a negative charge on the rubber. The amalgam naturally increases the friction and its results. (See principle 4.)

In such a friction machine, every portion of the disk, after having passed between the rubbers, approaches in its revolution a conductor with a series of sparge metal points directed against the glass. The charge of positive electricity on the glass abstracts the negative charge from the neutral conductor, E, Fig. 1, and leaves the latter charged with positive electricity, while that portion of the disk which has just passed the points is charged with negative electricity. (See principle 2 above.)

If a di-electric is placed between the excited disk and the conductor, as shown in Fig. 1, the same action takes place, and (see principle 6 above) the conductor becomes charged with + electricity, but that portion of the di-electric which faces the points becomes charged with — electricity.

2. THE DI-ELECTRIC INDUCTION APPARATUS.

It is more difficult to give a clear explanation of the action of the second part of this apparatus. To facilitate a thorough understanding of the process, I give the annexed diagram.

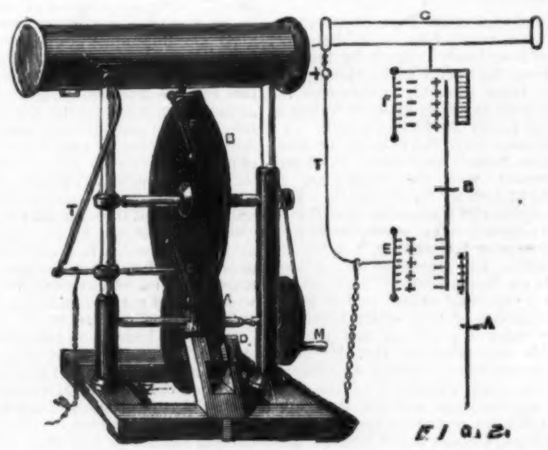


FIG. 1. FIG. 2.

CARRE'S ELECTRIC MACHINE.

A represents the glass disk of the friction machine, whose upper portion, before passing the points, is charged with + electricity. It acts through the di-electric disk, B, on the opposite conductor, E, which discharges — electricity on the di-electric, and becomes itself charged with + electricity. (See principles 6 and 2 above.) But the di-electric in revolving carries the part that was thus charged with — electricity to the place opposite the top conductor, F; it there abstracts + electricity from H F, becomes itself charged with — electricity (until it again passes opposite E), and leaves F charged with — electricity. (See principle, Fig. 2.) By means of a brass chain, shown in the illustration, Fig. 1, the conductor, E, can be connected to "earth." If the disk, A, were charged with — electricity, then the same process would occur, but in that case T would be charged with — electricity, while F and C would acquire a positive charge.

The machine has two more appendages, shown in the illustrations, of which we have not spoken yet. They are: (1) a rectangular piece of vulcanite fixed opposite, but parallel to F on the other side of the di-electric; and (2) the large metal conductor, C. The slab of vulcanite increases the length of spark by one-third. The large metal conductor at the top fulfills a similar task. The brass rod, T, is movable at its lower extremity, so that the brass ball fixed at the top of this rod can be placed at any desired distance from C to indicate any length of spark produced.

Some such machines are made with glass disks, others have plates of ebonite. Both substances are equally effective and suitable for the purpose. A machine with a disk of 20 in. diameter will produce a continued series of sparks, 5 in. to 7 in. in length. It is powerful enough to brilliantly illuminate several feet of Geissler's tubes, pierce glass, and produce all the effects that can be obtained from the secondary current of a large induction coil.

Carré's machines are made in three sizes, having pairs of disks of the following diameters respectively, 12¼ in. and 17¼ in., 15 in. and 21¼ in., 17¾ in. and 23¼ in.

Those of our readers who have occasion to experiment with friction machines, know that these are very sensitive to moisture in the atmosphere. The well known Holtz machine is even more sensitive than the former apparatus; but Carré's instrument is less susceptible to the evil effects of moisture in the air, and, therefore, recommends itself to the experimenter.

It possesses another and even greater advantage over the induction machines of Holtz and Bertsch, in not requiring any initial charge from without, or necessitating any preparation. It is a self-starting machine. To set the apparatus to work you simply turn the handle, and within *one* minute's time you hear the peculiar crackling noise which accompanies the long bluish sparks that pass between the conductors, C and I.

Our querist asks for "a few hints as to the best mode of keeping the apparatus in working order." 1, keep the machine in a dry place; 2, do not allow the points of E and F to touch the disk; and 3, when needed put a little fresh amalgam on the rubbers. You will find that the instrument does not easily get out of order, and will always be ready for good action. T. WIESENDANGER.

THE MOST POWERFUL TELESCOPE IN EXISTENCE.

By E. NEISON, F.R.A.S.

WHICH is the most powerful telescope in existence? Define the meaning which ought to be attached to the adjective "powerful" in this question. The most powerful telescope in existence is that existing telescope which can do the most work. The work of a telescope may be said to be to enable you to see and to enable you to measure. Therefore, that telescope with which you can see most and can measure best is that which can do the most work, and is unquestionably the most powerful telescope in existence.

Which is the most powerful telescope in existence?

Every one has heard of the two giant telescopes which were constructed nearly forty years ago by the late Lord Rosse, and which were erected at his residence at Parsonstown, about fifty miles from Dublin. The first great telescope constructed by Lord Rosse was a reflecting telescope, with a speculum three feet in diameter and twenty-six feet in focal length. It was carried in a ponderous tube moving in a massive iron mounting by means of ingenious machinery. When it was finished, in the year 1840, it was considered the grandest instrument in science, and from its employment in the study of the heavens enormous advantages were expected to be gained for astronomy.

Scarcely, however, was this telescope out of the hands of its maker, than Lord Rosse resolved to construct a second telescope of still larger dimensions. With enormous skill, patience, and ingenuity Lord Rosse carried out this intention, and by the year 1846 had finished his second grand telescope, the instrument commonly known as "Lord Rosse's telescope." It has a metal speculum six feet in diameter and fifty-four feet in focal length. This enormous mirror, which weighs nearly four tons, is placed in a great tube eight feet in diameter and fifty feet in length, and this tube is carried by a massive iron mounting supported by two lofty castellated buildings, each nearly sixty feet in height. The weight of the telescope and its mountings is enormous. By ingenious methods the observer who is using the telescope is placed in a kind of cage suspended in the air from the mounting of the telescope, and carried up and down along with the instrument.

To this day this giant telescope of Lord Rosse's retains its position as the greatest telescope in existence. In its enormous size it has still no rival; in its massiveness and weight it is long likely to retain its pre-eminence.

Which is the most powerful telescope in existence?

Lord Rosse's giant telescope, of course, will be the answer of most people; it will be the answer of the great majority of scientific men; it would be almost the unanimous answer of the British Association, of that Section A which is supposed to keep the world informed of the great achievements of astronomy and optics.

Is this the true answer?—No.

To most people, to most scientific men, this answer will come like a shock, for to them it has long been a cherished tradition, an article of faith, almost an axiom, that Lord Rosse's giant telescope was the most powerful telescope in existence. To those astronomers who are observers, astronomers not stargazers, it is well known that for years this giant telescope of Lord Rosse's has been beaten in power by far smaller and more compact rivals. In fact, it is doubtful whether in real power it is much superior to its smaller companion, the three-foot telescope.

There are many who judge a telescope by its size alone, who compute its excellence by aid of a two-foot rule and a knowledge of its cost in pounds. With them a telescope with a metallic speculum weighing four tons, and measuring six feet in diameter, with a tube fifty feet long, and costing a thousand pounds, ought to give so much light, have such and such separating power, and show this or that object. It is true with small telescopes a great deal may be done in this way, but experienced observers know that the real power of a telescope can only be ascertained by a study of what it has done. Tried by this test, the giant telescope of Lord Rosse breaks down. It has not the accuracy of definition which constitutes the real power of a telescope, for it is mainly upon this that depends its capability for doing work. Compared with the metal specula which were made at the time when Lord Rosse's telescope was constructed, the great speculum of Lord Rosse's instrument might come out with credit. But great improvements have since then been introduced into the manufacture of reflecting telescopes, and the present silver-on-glass reflecting telescopes

successfully rival the finest achromatic telescope in definition and in power.

In days gone by repeated reference was made to the wonderful things which could be seen upon the surface of the moon with the two giant telescopes of Lord Rosse's. Picturesque descriptions were given of the minute features which were visible; amazement was often expressed at the small objects which could be seen. Still more interesting accounts were given of what *ought* to be visible—a carpet of pronounced pattern as big as Lincoln's Inn Fields, the Castle at Dublin, the court house at Cork, a house, or even a man, provided he were big enough. All these *ought* to be seen if they happened to be on the lower surface. Yet when we come to consider what it really is which is described as being seen, when we calmly examine the various drawings which have been made by the aid of one or the other of these great telescopes, then we find that they show nothing which cannot be distinctly seen and drawn by the smallest astronomical telescope of high excellence.

An enormous blaze of light is gathered by the telescopes; but all this light reveals nothing which cannot be seen with far greater ease in a far smaller telescope. There are in existence a number of drawings of the planets, and observations of their satellites; there are also observations of close double stars, or faint companions to bright stars, all made with one or the other of these two telescopes. Yet nothing has been seen which is beyond the power of a good astronomical telescope of comparatively moderate aperture. It is only in observing the dull ill-defined nebulæ that Lord Rosse's great telescope has any exceptional advantage, though even in this respect it is probably much overrated. As an astronomical telescope either of Lord Rosse's telescopes would be fairly beaten by either of the fine eighteen-inch reflectors which are now in existence.

If, then, Lord Rosse's great telescope is not the most powerful in existence, what answer is to be given to the question with which we commenced? Which is the most powerful telescope in existence? There are the great refractors of Pulkova and of Cambridge, U. S., each of 15 inches in diameter and 23 feet in focal length. There is the still larger refractor of Chicago, with an aperture of 18 inches and a focal length of 23 feet. All these instruments are of high excellence in defining power, the essential point where Lord Rosse's breaks down. There is the reflector of Mr. Lassells, with its metal speculum of two feet in diameter and its tube 20 feet in length. There is the great Melbourne reflector, with its great metal speculum of 48 inches in diameter, the second largest telescope in the world, but by no means so sharp in definition as might be desired, so that it failed to reveal the satellites of Mars, which were seen with an instrument of not one-sixth the diameter in Europe.

There is, also, the great reflector of the Paris Observatory, with a silver-on glass speculum nearly four feet in diameter, an instrument whose power is seriously injured by the imperfect definition arising from the flexure of its thin speculum. There is, also, the large refractor constructed for Mr. Newall, of Gateshead, with an object-glass 25 inches in diameter, mounted in a tube nearly 30 feet in length.

But all these instruments must yield the palm to the great refractor of the United States Naval Observatory at Washington, a splendid instrument, with an object-glass 26 inches in clear aperture and 33 feet in focal length. This magnificent instrument is equatorially mounted and driven by clockwork, so that it is complete as an astronomical telescope. The Washington refractor is, however, not merely a telescope of great dimensions; like more than one of those previously mentioned, it is an instrument of high optical excellence. Its definition is crisp and sharp, and it brings every ray of the enormous amount of light which it collects to a sharp focus at a very minute point, so that none is wasted. It was with this fine telescope that Professor Asaph Hall made his famous discovery of the satellites of Mars, that Mr. Burnham discovered a number of the most minute companions to the brighter stars, and that Professors Newcomb, Holden, and Hall have observed and measured the smallest satellites of Saturn, Uranus, and Neptune. It is this magnificent instrument which is supposed by most astronomers to be the most powerful telescope in existence. Then our answer to the question with which we have commenced ought to be—the great refractor of the Washington Observatory. No!

Then which is the most powerful telescope in existence?

The most powerful telescope in existence is the magnificent new reflecting telescope which has been just finished by Mr. A. Ainslie Common, and is erected at his residence at Ealing. This telescope has a silver-on-glass speculum 37½ inches in diameter, and a focal length of just over 20 feet. It is equatorially mounted in a novel but most efficacious manner, and is driven by a powerful clock, controlled in an ingenious manner by a method invented by Mr. Common. This new telescope, which has only been finished about a month, has turned out a great success, and is unquestionably the finest and most powerful telescope which is in existence.

For the last three years Mr. Common has had in his observatory a fine silver-on-glass reflector with an aperture of 18 inches and a focal length of nearly 10 feet. This telescope was mounted by him on an equatorial stand of his own design, on what is known as the "Sissons" principle. For efficiency, power, and excellence, this eighteen-inch reflector is as yet without a rival in England, and was only beaten, perhaps, by the great refractor of the Washington Observatory. With this instrument was made a number of observations of the faint satellites of Saturn and Uranus, which rendered the Ealing Observatory a familiar name to all astronomers.

When, in 1877, the astronomical world was electrified by the announcement of Professor Asaph Hall's discovery of the two satellites of Mars, it was to Ealing that astronomers looked for systematic observations of these faint objects, and it was from Ealing Observatory that came the only systematic series of measures of these objects which has been furnished by England. Astronomers may congratulate themselves, therefore, upon this new telescope being in good hands, and in an observatory where it will not be allowed to rust in idleness like so many of the finest instruments in England.

Satisfied from the performance of his eighteen-inch Newtonian reflector that it would be possible to successfully construct much larger instruments of this kind, it seems to have been about two years ago that Mr. Common first seriously thought of constructing a very large reflecting telescope with a silver-on-glass speculum. It was obvious that this would be a serious undertaking, and one which would require much thought and ingenuity to carry it out successfully. Many difficulties would require to be boldly faced and successfully overcome. The expense alone would have been sufficient to deter most men. Experience, skill, courage, perseverance, money—all would be required if success was to be won.

It was decided to first undertake the manufacture of a telescope with an aperture of 37½ inches, and a focal length of about eighteen or twenty feet. This was a much shorter focus than had usually been thought essential for an instrument of this large aperture. Generally, instruments of this kind are made with a focal length of from nine to ten times their diameter. This would correspond to about thirty feet focus for a speculum of the given size. The fine performance of his eighteen-inch telescope had convinced Mr. Common that it was not necessary to give a greater focal length than fifteen or sixteen feet. But there were two conflicting interests to be reconciled. The shorter the instrument the easier it would be to mount and the easier to observe with; but, on the other hand, the longer the focus the better it would be for taking photographs of the heavenly bodies, and this last was one of the main uses that the new telescope was intended for. With the view of best reconciling these two views the instrument was designed with a focus of some twenty feet.

The very first step to be taken was to undertake the manufacture of the glass speculum, and here at the outset an enormous difficulty presented itself. To make a speculum of the required dimensions it was necessary to have a disk of good crown glass about thirty-eight inches in diameter, and from six to nine inches in thickness. Well, purchase such a disk; or rather, as it was not likely that such a thing could be bought ready-made, why, order one. This seems feasible enough. But there was not a firm in England who would undertake to make such a thing. In fact, at the time, the opinion was freely expressed that such a thing could not be made. This was a serious obstacle, for nearly all the glass used for optical purposes came from England. Determined not to be baffled, Mr. Common applied to a French firm, and they produced the disk of glass which was essential before a single step could be taken. The first difficulty was faced and overcome.

After mature consideration the grinding and polishing of the speculum into which this glass disk was to be turned was intrusted to Mr. G. Calver, of Widford, a well known maker of glass specula. From its enormous size, over twice as large and ten times as heavy as any speculum which had ever been manufactured before, it was necessary to construct new and more powerful machinery, and even a new building. Nothing daunted, however, Mr. Calver agreed to do his best to turn this great mass of glass into an excellent speculum, though, of course, he could not guarantee anything, the entire risk necessarily remaining with Mr. Common.

This settled, the greater portion of the task remained to be faced. Given a speculum of the specified size, how was it to be mounted, and how was it to be used? First, the glass speculum must be mounted with such care that, despite its enormous weight, it must nowhere bend by as much as one ten-thousandth of an inch. Secondly, the glass speculum and the iron cell which supports it must be fastened at the end of a tube some twenty feet in length, and this tube must be supported by an elaborate mounting by which it can be pointed to any desired part of the heavens, and moved by clockwork so as to follow the apparent motion of the celestial bodies. Thirdly, arrangements must be made so that an observer can always use the telescope, and be enabled to look through the eyepiece of the telescope whatever position it may be in—no slight task, seeing that the said eyepiece must, in some positions of the instrument, be over twenty feet from the ground. Lastly, the telescope must have an observatory which will shield it from the weather, and yet permit any part of the heavens to be examined with the telescope.

When the instrument has a metallic speculum, like the large reflecting telescopes of Lord Rosse and Mr. Lassells, and that at Melbourne, it is much easier to satisfy the first condition than when the speculum is made of glass; for it is possible to cast the speculum with grooves, projections, and recesses in its back, by means of which the task of supporting it is much simplified. With a glass speculum it is not practicable to have these aids, so that the back of the speculum is cast quite flat, and usually rests on a flat plate of metal. By an ingenious method of balanced arms, Mr. Common has contrived to support the speculum so that it is perfectly free from flexure. Thus the first point was secured.

The second point, or the method by which the telescope should be mounted, was a problem which required long and serious consideration. Mr. Common devised a new and most ingenious method which, after long consideration, he thought would furnish a means of steadily supporting the telescope. In this steadiness is most essential, the slightest vibration—vibrations absolutely invisible to the eye—would ruin the performance of a telescope. The weight of the moving part of the telescope amounts probably to four or five tons, and this has to be kept in motion by a clock, yet it must not be liable to the least tremor or vibration. The difficulty of the problem is evident.

His plan of a mounting was submitted by Mr. Common, for criticism, to several well-known astronomers, who might be supposed competent to advise on this subject. As might have been expected, very diverse opinions were expressed; at most, one seemed to decidedly favor the plan, others seemed doubtful, and more than one were decidedly adverse. The result was to leave that matter much as it stood at first, so that Mr. Common decided to persevere in his original design. The success which has crowned his labors shows that he was correct in his judgment.

It would be impossible to describe the method of mounting employed without the aid of several detailed drawings, but reference may be made to one ingenious point. As in all equatorial mountings, nearly the entire weight of the moving part of the telescope (in the present telescope five tons) rests on the bottom pivot of the polar axis. This pivot, therefore, is exposed to enormous friction, and is a common cause of vibration. To obviate this, Mr. Common, by an ingenious arrangement, supports the whole polar axis in mercury, thus taking off nearly the entire friction, and the whole instrument moves as if it were floating. By this means he is enabled to drive the whole telescope by means of an ordinary train of clockwork, regulated by the governor, which he had invented for his smaller telescope.

The last two points specified above are obtained by making the observatory itself the ladder by which you approach the eye end of the telescope, and the whole observatory revolves on iron wheels running on a circular railway. By means of a wheel on your left, you can raise or lower yourself at pleasure, and observe with the telescope in any position. The whole observatory only requires moving about once in two hours, and can be moved with ease by one hand.

Within a year of its being begun, the telescope was rapidly approaching its completion. The great speculum had been brought to the right shape, and was partially polished, and every day the announcement was expected that it was completed, or at least only required the final finishing touches. Suddenly a telegram arrived—an ominous thing. Was it to announce an imperfect figure? This would be a most annoying thing, for it would require the whole to be reground and repolished. But no, it was very brief, but it announced a terrible misfortune. It was a pressing request to come down at once. *The whole speculum had burst into a thousand pieces.*

It was a terrible blow, for it was the very misfortune which had been prognosticated by the English manufacturers and by the greater number of astronomers, including those who had had much experience in the construction and use of specula. The explosion had been terrific. The whole workshop was covered with jagged, torn masses of glass, varying in weight from ten or twelve pounds to an impalpable dust. Mr. Calver had had a narrow escape, but he and his workmen escaped without serious injury. The monetary loss was great, and bid fair to be greater, for with the loss of the speculum the rest of the telescope became useless. It might well seem that they were right who held the view that large silver-on-glass specula were impracticable, as from the difficulty in annealing large masses of glass they might be expected to break at any moment.

Within an hour or two of receiving the telegram announcing this terrible mishap, Mr. Common was in the library of the British Astronomical Society. While there he was met by a friend, a fellow astronomer, who, being aware that news was daily expected of the completion of the great speculum, asked him for the latest intelligence. Mr. Common calmly handed him the fateful telegram. He was thunderstruck, for it was so unexpected, and he was one of those who had looked for much gain to astronomy to accrue from the construction and subsequent employment of this grand new instrument. After expressing, no doubt imperfectly enough, his sorrow, sympathy, and disappointment, he naturally put the question: "What can you do now?" The answer came gently enough: "Do! Why I have telegraphed over to Paris to see if I can't get two more disks of glass. It will be one to spare in case of another explosion."

Success must crown indomitable courage like this. The new disks arrived, and were duly transferred to Mr. Calver. One was selected, and, after much labor, ground, polished, and finished. The remaining portion of the instrument and the observatory were pushed on as quickly as possible. On August 1, 1879, the instrument was complete, and the grandest and most powerful telescope in existence stood finished before its maker, designer, and owner.

An instrument of this large aperture will take a long time to thoroughly test, but it has stood triumphantly all the tests which have been applied hitherto. It has been tested on the moon, a most crucial test in experienced hands; on Jupiter and Saturn, and on faint companions to bright stars. In all cases satisfactory results have been obtained.* This proves that the telescope must be at least of fine quality, and it bids fair to turn out of the highest excellence. It has been used to take photographs of the moon, with results very satisfactory to those who are experienced in these matters. There can be no doubt, therefore, of its claims to be a success, so that ere long it will take its place in the eyes of most astronomers as the greatest optical instrument in existence, and the credit of having manufactured and of possessing the most powerful telescope in existence has now passed from America back to England.

It may be legitimately asked, What will be the future work of this grand instrument? Will it be used to increase our knowledge of astronomy, or will it be allowed to rest in idleness, like so many other fine instruments? It is to be trusted, and it may be safely anticipated, that the former will be its fate. It will wear out, not rust out.

There is much in astronomy which this grand telescope can do. It can be used for observing the faint and difficultly visible satellites of Mars, Saturn, Uranus, and Neptune. All these pressingly want observing and measuring, and there are few telescopes of sufficient power and excellence to do the work wanted. It can be easily done with the new one. Then there is the important question to be settled, Are there other satellites to those planets than those known? To this telescope will fall the task of searching for a third and more distant satellite of Mars, for a fifth satellite to Jupiter, for a ninth and tenth satellite to Saturn, for a fifth and sixth satellite to Uranus, and perchance half a dozen new moons of Neptune. Moreover, there are the extremely interesting problems connected with the minor planets. Does Vesta, Juno, or Pallas possess a satellite or satellites? If so, their discovery would be a great thing to astronomy. Astronomers suspect that away beyond Neptune there may be still another giant planet, still another member of the solar system. If so, it will be very faint, and it will require a powerful telescope to search for and discover it.

There is yet another field in which this new telescope may reap great advantages for astronomy. It is suspected that more than one of the stars, those distant suns, may be attended by opaque dull planets.

Lastly, there is the great field of photography. The new telescope takes instantaneous photographs of the moon two and a-half inches in diameter; photographs which can be enlarged with ease to good pictures of the moon a foot in diameter; pictures which will be valuable for astronomy, not mere interesting curiosities of science. It will, moreover, take photographs of Venus, Jupiter, Mars, and Saturn, showing much detail, and capable of being enlarged to half an inch in diameter. These planetary photographs will be of great use as recording in unmistakable characters the true position and aspect of these planets and their satellites at different known epochs.—*Popular Science Review.*

CUMBERLAND, MD.

The authorities of the city of Cumberland, Md., are taking measures calculated to call the attention of capitalists and manufacturers to the advantages offered by this city for the establishment of iron, steel, glass, terra cotta, and woodenware works.

With cheap coals, competitive freights, unlimited supplies of raw material, a location unequaled for health, beauty, and low cost of living, it is highly probable that this point is destined to become an extensive manufacturing center.

* Lately this telescope has shown the outer satellite of Mars three weeks before it was thought possible it could be seen with the great telescope at Washington.